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Attorneys for Plaintiffs

**UNITED STATES DISTRICT COURT**

**FOR THE CENTRAL DISTRICT OF CALIFORNIA**

| | |
|---|---|
| CENTER FOR BIOLOGICAL DIVERSITY, et al.<br><br>Plaintiffs,<br><br>v.<br><br>UNITED STATES ARMY CORPS OF ENGINEERS, et al.<br><br>Defendants. | Case No. CV 14-01667 PSG (CWx)<br><br>**REQUEST FOR JUDICIAL NOTICE IN SUPPORT OF PLAINTIFFS' MOTION FOR SUMMARY JUDGMENT** |

Pursuant to Federal Rules of Evidence, Rule 201, Plaintiffs respectfully request that the Court take judicial notice of the following documents, attached hereto as exhibits:

1. U.S. Environmental Protection Agency memo regarding higher level review of a Clean Water Act Section 404 Permit for Potash Corporation of Saskatchewan, dated March 17, 2009.

2. U.S. Environmental Protection Agency Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses, from 1985.

3. U.S. Army Corps of Engineers memo regarding elevation of a Clean Water Act Section 404 Permit for Hartz Mountain Development Corporation, dated August 17, 1989.

Federal Rule of Evidence 201 provides that judicial notice may be taken of facts that are not in dispute either because they are (1) "generally known within the territorial jurisdiction of the trial court, or (2) capable of accurate and ready determination by resort to sources whose accuracy cannot reasonably be questioned." Records, reports, and other documents on file with administrative agencies, such as the United States, U.S. Environmental Protection Agency ("EPA") and the U.S. Army Corps of Engineers ("Corps") meet these requirements and can be judicially noticed. *Westways World Travel, Inc. v. AMR Corp.*, 2005 U.S. Dist. LEXIS 47293, 6 (2005); *Tampa Elec. Co. v. Nashville Coal Co.*, 365 U.S. 320, 332 (1961); *Lee v. City of Los Angeles*, 250 F.3d 668, 689-690 (9th Cir. 2001). Judicial notice of public records is limited to taking judicial notice of the existence of those records and the statements within those records.

To qualify for judicial notice, the document must be "capable of accurate and ready determination by resort to sources whose accuracy cannot reasonably be questioned." Fed. R. Evid. 201(b). All three documents meets this test, as the EPA's memo is readily available at http://water.epa.gov/lawsregs/guidance/wetlands/upload/PCS_R4-elevation-request-to-

EPA-HQ_3-17-09.pdf, the EPA guidelines are readily available at http://water.epa.gov/scitech/swguidance/standards/criteria/aqlife/upload/85guidelines.pdf, and the Corps' memo is readily available at http://water.epa.gov/lawsregs/guidance/wetlands/upload/2006_04_19_wetlands_HartzMountainGuidance.pdf. These documents are a proper subject for judicial notice and provide insight on the agencies' legal interpretation of their obligation under the Clean Water Act's 404(b)(1) guidance. Accordingly, Plaintiffs request that the Court take judicial notice of all three documents.

Dated: March 2, 2015

Respectfully Submitted,

/s/ John Buse

John Buse
Adam Keats
Aruna Prabhala
CENTER FOR BIOLOGICAL DIVERSITY
Attorneys for Plaintiffs Center for Biological Diversity, Friends of the Santa Clara River, and Santa Clarita Organization for Planning the Environment

# Exhibit 1

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

March 17, 2009

**MEMORANDUM**

**SUBJECT:** Request for Higher Level Review of Wilmington District Permit Permit AID 200110096, Potash Corporation of Saskatchewan, Phosphate Division, Aurora Operation Mine Continuation

**FROM:** A. Stanley Meiburg
Acting Regional Administrator, Region 4

**TO:** Michael H. Shapiro
Acting Assistant Administrator
Office of Water

I am requesting that you seek review by the Assistant Secretary of the Army (Civil Works) of a proposed Clean Water Act (CWA) Section 404 permit to the Potash Corporation of Saskatchewan, Phosphate Division, Aurora Operation, to be issued by the Corps of Engineers Wilmington District. This request for elevation of the Corps permit is being made pursuant to Part IV paragraph 3(d)(2) of the Memorandum of Agreement (MOA) between the U.S. Environmental Protection Agency (EPA) and the Department of Army, under CWA Section 404(q). The Wilmington District issued a Notice of Intent to Proceed on this permit under a letter dated February 24, 2009, and received by the regional office on March 2, 2009. The proposed project involves the mine expansion of the 1997 permit, and will impact 3,953 acres of wetlands and 25,727 linear feet of streams, including a portion of a Significant Natural Heritage Area designated as "nationally significant."[1] The project, as currently proposed, will result in a loss of approximately 70 percent of the watersheds of the project area streams which drain to estuaries of the Pamlico River.

EPA remains concerned that the proposed project will result in unacceptable adverse impacts to aquatic resources of national importance, including direct and indirect impacts to waters of the U.S. which support the nationally significant Albemarle Pamlico Estuary System. We have actively coordinated with the Wilmington District and the applicant over the past eight years through the Section 404 and National Environmental Policy Act processes to resolve our concerns regarding this project. However, based on our review of the economic analysis included in the project's Final Environmental Impact Statement (FEIS), we continue to believe there are less environmentally damaging practicable alternatives for mining the project site. We also believe that there are significant opportunities to avoid and minimize impacts to important wetland and stream resources on the project site, as well as opportunities to improve the compensatory mitigation required to offset the permitted impacts.

[1]The NC Natural Heritage Program (NHP) designates areas it believes to be important for the conservation of the state's biodiversity as Significant Natural Heritage Areas (SNHAs). These areas can be designated as significant at the county, regional, state or national level. This nationally significant designation by the NC NHP means the Bonnerton SNHA has been determined to be one of the five best examples of this community type in the nation.

We have been working closely with your staff on this issue and will continue to do so as we proceed to the next stage of the MOA process. Attached for your review is our July 23, 2008, letter to Colonel Ryscavage regarding this project's FEIS which discusses our outstanding concerns with the proposed project in more detail. We have already shared extensive background material with your staff, and will continue to prepare and forward information regarding this matter.

Attachment

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

July 23, 2008

Colonel Jefferson Ryscavage
District Engineer
U.S. Army Corps of Engineers
Wilmington District
P.O. Box 1890
Wilmington, NC 28402-1890

Attn: Tom Walker
Project Manager
File Number 2001-10096

Subject: COE Regulatory Final Environmental Impact Statement (FEIS) for "PCS Phosphate Mine Continuation"; Aurora, Beaufort County, NC; CEQ# 20080213; ERP# COE-E67005-NC

Dear Colonel Ryscavage:

Pursuant to Section 102(2)(C) of the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act, EPA Region 4 has reviewed the above-referenced U.S. Army Corps of Engineers (COE) regulatory Final Environmental Impact Statement (FEIS). This FEIS evaluates the environmental consequences of the Applicant's (Potash Corporation of Saskatchewan Phosphate Division: PCS) proposed expansion of its phosphate mining operations adjacent to the Pamlico River, South Creek and associated tributaries, north of Aurora in Beaufort County, North Carolina.

EPA has previously provided NEPA comment letters on the Draft EIS (DEIS) and its Draft Supplement (DSEIS). Our December 28, 2007, DSEIS letter continued to describe our environmental objections to this mine continuation project, as proposed. Similarly, from a Clean Water Act (CWA) section 404 permitting standpoint, the EPA Region 4 Wetlands Regulatory Section also objected to this proposal pursuant to CWA Section 404(q), Part IV, paragraphs 3(a) and 3(b), in letters dated February 9 and March 6, 2007, respectively. The Wetlands Regulatory Section also provided pre-FEIS comments in a April 30, 2008, letter regarding the significant natural heritage area on the Bonnerton tract, the scope of the section 404 silviculture exemption, and the economic evaluation/Least Environmentally Damaging Practicable Alternative (LEDPA) determination. We offer the following comments on our current review of the FEIS.

**Background**

In November 2000, PCS submitted to the COE Wilmington District an application for the mine continuation project in the Aurora area. PCS modified the original permit application in response to public notice comments to further reduce impacts to federal waters of the U.S. This modified application was the subject of the COE's regulatory DEIS (10/2006), which described the No Action Alternative and nine action alternatives. PCS's application evaluated in the DEIS was for mining of the NCPC tract involving 2,408 acres of mining impacts to waters of the U.S. (*i.e.*, Applicant Preferred or AP alternative). Among the alternatives, the DEIS included three basic tracts (NCPC, S33 and Bonnerton tracts) with varying impacts to waters of the U.S. as holistic mining plans, including the Applicant's expanded AP alternative (EAP) with 5,667 acres of mining impacts of waters of the U.S. The public review of the DEIS and further discussions with the Applicant concerning economic practicability lead to the development of the DSEIS (11/2007), which introduced new Alternatives L and M. Alternative L follows the SCR boundary (see section 2.4.1.2) on the NCPC tract and defines a new boundary on the Bonnerton and S33 tracts. Alternative M was developed by the Applicant and consists of a boundary with three more years of mining on the NCPC tract than the L alternative and is identical to the L alternative on the Bonnerton and S33 tracts. In an April 25, 2008, letter, the Applicant requested its application be modified to request a permit for Alternative L.

**Impacts & Alternatives**

EPA's primary concerns with the proposed continuation of phosphate mining at Aurora are the associated wetland and stream impacts to watersheds supporting the Albemarle Pamlico Estuary system over an extended timeframe, together with the cumulative impacts of ongoing mining. EPA understands the rationale behind the development of the new Alternatives L and M through the NEPA process, but has concerns over the level of impacts to waters of the U.S. associated with these alternatives.

EPA appreciates that several alternatives were considered by the Applicant and COE during the NEPA process and documented in the EIS. In the FEIS, these alternatives were the AP, EAP, SJA, SCR, DL1, S33AP, L and M alternatives. Of these, EPA has identified the S33AP Alternative, which the COE has determined to not be practical (see below), as the NEPA "environmentally preferable alternative," because it substantially reduces the wetland impacts for the proposed mining continuation. Although the acreage of impacted wetlands for S33AP is not insignificant (1,123 acres: ac), this action alternative impacts the fewest wetland acres. We believe that impacts to wetlands north of NC33 will have a potentially greater impact to the watersheds supporting the nationally significant Albemarle Pamlico Estuary system. Moreover, based on EPA's economic evaluation of practicability, we also find that S33AP is economically practicable (see *Economic Considerations* section and *Detailed Comments* enclosure of this letter). We also note that S33AP would nevertheless impact a high number of stream sections (33,486 linear feet: lf). Any implementation of S33AP should further avoid and minimize stream and wetland impacts.

The FEIS (5/2008) provided additional information on Alternatives L and M. The FEIS lists Alternatives SCRA[1], SCRB, SJAB, DL1B, S33AP and the No Action alternative as not being practicable, while finding that Alternatives AP, EAPA, EAPB, SJAA, L and M were practicable. The COE indicates that of the alternatives identified as practicable, the L alternative is the most restrictive and therefore avoids the most aquatic resources. Alternative L would impact approximately 4,135 acres of waters of the U.S. over a 37-year mining span. The 11 community types within the impacted waters of the U.S. include pocosin-bay forests (264 ac), bottomland hardwood forests (73 ac), hardwood forests (1,075 ac) as well as 29,288 linear feet of perennial and intermittent streams. These community types are located within an approximate 11,909-acre mine advance distributed throughout the project area. Impacts of Alternative M include 4,592 acres of waters of the U.S. and 36,990 linear feet of streams over a 41-year mining span.

The COE does not identify a NEPA "preferred alternative" or a LEDPA in the FEIS. However, Alternative L was considered the Applicant's "Proposed Action" in the COE's FEIS and Public Notice (pg. e). PCS's previous mining application was for the AP (NCPC tract only).

**"Modified Alternative L"**

While we believe that S33AP is the "environmentally preferable alternative", EPA prefers Alternative L (of the alternatives determined to be practicable by the COE in the FEIS) from a NEPA perspective since it avoids valuable wetland habitat, mainly on the NCPC tract. The COE's economic analysis indicates Alternative L is the alternative which would allow the least environmental impacts and still be economically practicable (pg. 2-32). EPA agrees that Alternative L is economically practicable (see *Detailed Comments*); however, we also believe that it could be improved environmentally through further avoidance of waters of the U.S.

Nevertheless, we acknowledge that Alternative L does avoid a large portion of the important tidal creeks and some of their associated watersheds on the NCPC tract and an approximate 58-acre area of biocommunity type 7 ("wetland hardwood forest") on the Bonnerton tract, as shown on Figure 4-7b (Vol. I). This is the eastern portion of an approximate 271-acre plot within the Bonnerton base tract that has been designated as a "nationally significant" Significant Natural Heritage Area (SNHA) by the North Carolina Natural Heritage Program (NHP).

While we appreciate the Applicant's avoidance of this eastern portion of the SNHA, EPA strongly believes that the entire SNHA tract should be avoided. Therefore, in order for Alternative L to be improved environmentally, we recommend that Alternative L be further modified to also exclude the remaining approximate 213-acre component of the SNHA tract from the proposed mining. For convenience of reference, we have designated this modified alternative as "Modified Alternative L". Overall, EPA considers "Modified Alternative L" to be an economically practicable and

[1] The 'A' and 'B' portions of 'SCRA' and 'SCRB' indicate a sequencing for the SCR Alternative. Other sequenced alternatives were also labeled this way.

environmentally reasonable alternative that is more environmentally preferable than Alternative L.

In addition to the exclusion of the remaining 213-acre portion of the SNHA from mining, EPA also recommends that "Modified Alternative L" follow the original SCR boundary on the S33 tract rather than the proposed Alternative L boundary (this would approximately reduce wetland impacts by an additional 38 acres and stream impacts by 10,167 lf). Since we understand that the main purpose for developing the L alternative was to allow 15 years of mining north of NC33, it remains unclear why the SCR avoidance boundary on the S33 tract was decreased for Alternative L. We find no information in the FEIS which would indicate the COE has determined that the use of the original SCR boundary in the S33 tract would fail to make Alternative L economically practicable. In addition, the COE's response to the EPA comment on this issue in our DSEIS letter (Response R6, Appendix J) did not clarify our understanding of the need for this mining expansion on S33.

**Avoidance, Minimization & Mitigation**

Even with the exclusion of the SNHA from Alternative L and a return to the SCR boundary on the S33 tract, it is nevertheless clear that significant impacts to wetlands (3,864 ac) and streams (19,121 lf) would still occur by mining the Alternative L area over an extended period of time. Therefore, for any implementation of "Modified Alternative L" to be successful, we strongly believe the following actions would need to occur: 1) the ongoing process of minimization and avoidance of waters of the U.S. and the implementation of acceptable mitigation and reclamation of mined areas would continue to be applied to the remaining acreage; 2) the Wilmington District would continue its commitment to oversight of the reclamation process in a timely manner; and 3) strict compliance with mining Best Management Practices (BMPs) would be used during the permitted mining. In addition, for the excluded SNHA, the permitted mining in the surrounding areas must also not be allowed to indirectly affect the SNHA. Such indirect impacts could include disruption of its hydrology, the routing of mining stormwater runoff into the SNHA area, and degradation of the SNHA connecting areas such that they are no longer providing the connectivity function. To ensure success, the COE should provide a commitment to continue successful implementation of the avoidance, minimization and mitigation processes required under section 404(b)(1) in its prospective Record of Decision (ROD) for this EIS.

Because the SNHA would be wholly excluded from mining under "Modified Alternative L," silvicultural practices should not occur in this area until a final project decision is made. Logging on the SNHA site should be avoided since timbering degrades the SNHA's wetland value and national significance. We provided additional comments on the related section 404 silviculture exemption in the *Detailed Comments* and in EPA's April 30, 2008 letter.

If the S33 tract is mined under the S33AP Alternative or as part of the "Modified Alternative L", EPA recommends the completion of a detailed mitigation plan for impacts to the S33 tract well in advance of any plans to mine this area. The potential economic reopener clause may be an appropriate means to address this issue, if this tract were to be mined under "Modified Alternative L". EPA also recommends that the reopener clause, or other suitable measures, remain an option for future adaptive management needs. We also believe compensation for impacts to mature, high quality wetlands would require greater than the 2:1 mitigation ratio specified in the current mitigation plan. We understand the overall stream mitigation ratio of 1.8:1 is based on the 2003 Stream Mitigation Guidelines ratio determination methodology utilizing stream quality ratings of "poor," "good," and "excellent". We support the use of this methodology to determine appropriate stream compensation, but recommend the stream quality ratings be confirmed by the COE.

**Significance of the SNHA Resource**

The need to preserve the entire SNHA tract is based on the NHP designation (*i.e.*, nationally significant SNHA), the community types represented, and the contiguous nature of the SNHA. The NHP rates SNHAs by significance as national, state, regional and county. The "nationally significant" rating of the Bonnerton nonriverine wetland hardwood forest SNHA means the NHP considers this area to one of the five best examples of this community type in the nation. The size and maturity of this area are critical to the NHP rating.

Valuable biocommunity types are represented in the nationally significant SNHA. In addition to the eastern portion (58 ac) of the SNHA (within Porter Creek headwaters) already excluded from mining by Alternative L, the remaining 213 acres primarily consist of a western portion (135 ac) and a northwestern portion (45 ac). There are also two secondary connecting sections (totaling approximately 33 ac) for continuity of the wetland hardwood forest community. Of these, the most mature plots are the eastern portion within the Porter Creek headwaters and the western portion across from the Porter Creek area, which both have stands of mature (75-100 years old) "wetland hardwood forest" (biocommunity type 7). The two secondary areas of different biocommunity types serve to connect the main areas. Biocommunity type 5 ("wetland scrub-shrub") is found in the secondary area between Porter Creek and the western area and the biocommunity type 6 ("wetland pine plantation") is found in the portion between the western and northwestern areas. The northwestern area also contains biocommunity type 7, and was added to the SNHA after the recent NHP site visit. Although this area is not as mature as the other areas, the NHP concluded it should be added to the SNHA due to the rarity of the community type. The NHP considers this area to also be highly significant and to have good recovery potential over time. (We also note that if the biocommunity type 8 area ("wetland mixed pine-hardwood forest") located west of the northwestern portion of the SNHA was not mined due to logistical mining restrictions, it would provide an excellent opportunity for mitigation enhancement/rehabilitation, as recommended by the NHP.)

Beyond the functional significance of these biocommunities in terms of water quality and habitat value, the contiguous nature of the SNHA enhances its value. While not all of the SNHA acreage consists of wetland hardwood forested wetlands (*e.g.*, the western portion includes 20 acres of Suffolk scarp and the two secondary connection areas include biocommunity types 5 and 6), the interconnection of the three primary plots by the secondary areas makes the SNHA a functional unit of sufficient size to be sustainable. As a contiguous unit, this refuge "island" surrounded by permitted mining impacts, would allow for wildlife movement, foraging, and reproduction. In order to ensure this continuity, we recommend that the two secondary connection areas be maintained (if used as temporary crossing sites for mining equipment) so as to allow them to retain their connectivity functions for the wetland hardwood forest areas. The mast-producing stands of this "island" could also serve as a future seed source for the surrounding areas during post-mining reclamation. We commend the Applicant for its appreciation of the importance of SNHAs as supported by the statements in its mitigation plan encouraging preservation that will protect or extend SNHA(s) along the South Creek corridor.

**Economic Considerations**

We appreciate the COE's considerable efforts to evaluate the economic practicability component of the LEDPA requirement. However, we continue to have concerns with some aspects of the approach discussed in Section 2.7 of the FEIS. As we have stated on numerous occasions, the decision by the COE to incorporate the Applicant's position on how to average the cost of the mine relocation to a new tract, has made it very difficult to avoid some of the important project wetland areas in the LEDPA process. We acknowledge that the avoidance of an additional 213 acres on the Bonnerton tract under the "Modified L Alternative" would reduce the Applicant's mining north of NC33 to less than 15 years. However, our review of the dragline plan layout map for Alternative L (Vol. II, App. D) indicates this would only reduce part of years 11 and 12 for a likely overall reduction of approximately one year of mining. We understand this would not satisfy the COE's LEDPA requirement of 15 years north of NC33, but we believe such a reduction would not be an unreasonable alternative modification – especially considering the remaining concerns we have over the economic evaluation approach used to determine the LEDPA (see below). With the adjustments in mining on Bonnerton and S33 incorporated in "Modified Alternative L," the overall timeframe for mining would likely still exceed 35 years (instead of 37 years for Alternative L).

EPA's review of the FEIS included our National Center for Environmental Economics (NCEE) in Washington, DC. NCEE and other EPA staff have been involved extensively in economic practicability discussions with the COE, including the most recent meeting (1/30/08) with the COE and the Pamlico Tar River Foundation and its economist, to further discuss PCS economic practicability issues. In general, EPA does not believe considering costs in isolation, *i.e.*, without considering revenues, is a useful means to evaluate the economic practicability of the project alternatives. Comparing costs to revenues does not consider an applicant's financial standing or market share any

more than looking only at costs. As is pointed out numerous times in the FEIS, phosphate prices are determined by the global and national market (and not influenced by the Applicant's production levels). Comparing estimated costs (which the Applicant can control) to expected market prices (which the firm does not control) simply adds context to the cost numbers and allows for better decision making.

An appropriate method to evaluate practicability is by calculating the annual discounted net present value (NPV) of the stream of costs and revenues over the lifespan of each alternative. The NPV analysis is theoretically and empirically sound and EPA is legally required to use such analysis when evaluating all new regulations. Using the discounted NPV, projects of different lengths can be compared on equal terms. EPA (NCEE) has prepared an NPV table using OMB mandated discounted rates of 3 percent and 7 percent comparing the project alternatives. This summary table, with additional discussion on the economic practicability of the alternatives, is included in EPA's comments on the COE's responses to our DEIS comment letter provided in the enclosed *Detailed Comments*. We are available to discuss information concerning this summary table and how it was prepared.

Based on these calculations and as shown in our summary table, EPA believes that more alternatives appear to be practicable than those determined by the COE (*i.e.,* the COE believes that Alternatives AP, EAPA, EAPB, SJAA, L and M are practicable), including SCRA and SCRB, S33AP, SJAB and DL1. In fact, we find that all alternatives considered in the FEIS, except the No Action Alternative (*i.e.,* all the action alternatives), are economically practicable. Based on this analysis, the "Modified Alternative L" would also be an economically practicable alternative, despite its slightly shorter mining term. Since "Modified Alternative L" allows more mining than the SCR alternative (but less than the original Alternative L), we strongly believe that "Modified Alternative L" will be economically practicable and will have a positive NPV greater than the SCRA and SCRB Alternatives, but slightly less than the original Alternative L. With detailed cost and annual production estimates, it would be relatively straightforward to calculate a more precise value.

**Other Comments**

In addition to these primary concerns, EPA has also reviewed the COE's responses in the FEIS to our EPA NEPA letter on the DEIS (pg. J-111.A.1) and DSEIS (pg. J-111.B.1), as well as the EPA Wetlands Regulatory Section's letter pursuant to CWA Section 404(q), Part IV, paragraph 3(a) (pg. J-111.A.2) and the EPA Regional Administrator's letter pursuant to CWA Section 404(q), Part IV, paragraph 3(b) (pg. J-111.A.3). Copies of these letters and the COE's responses to comments are found in Appendix J of Volume IV. Our follow-up comments on selected responses, as well as other project topics, are provided in the enclosed *Detailed Comments*.

**Summary**

EPA finds that the proposed continuation of PCS mining at Aurora would have significant and long-term, direct and cumulative impacts to biocommunities in various waters of the U.S. which support the nationally significant Albemarle Pamlico Estuary System. Accordingly, we continue to have environmental objections to this project, as proposed, under Alternative L (Applicant's Proposed Action). However, we believe that S33AP is the NEPA "environmentally preferable alternative" and that Alternative L could be improved environmentally as "Modified Alternative L". EPA finds both to be economically practicable and, from an industry standpoint, both would allow the continuance of phosphate mining at Aurora for many years.

"Modified Alternative L" would avoid not only the eastern portion (58 ac) of the SNHA (Alternative L) but would also avoid the remaining acreage (approximately 213 ac) of the entire SNHA tract (approximately 271 ac). This alternative would also use the original SCR boundary for S33, as opposed to the additional wetland (38 ac) and stream (10,167 lf) impacts to this area proposed in Alternative L. EPA believes the SNHA to be an aquatic resource of national importance. The NHP-designated "nationally significant" SNHA includes nonriverine wetland hardwood forest and other functional community types and, if excluded from mining, would continue to be a contiguous and sustainable refuge "island" of one of the most threatened of North Carolina's natural communities. EPA considers "Modified Alternative L" to be an economically practicable and environmentally reasonable alternative that is more environmentally preferable than new Alternative L. However, for any implementation of "Modified Alternative L" to be successful, it should be understood that the ongoing processes, such as avoidance and minimization of impacts to waters of the U.S., implementation of acceptable mitigation and reclamation, and use of mining BMPs would need to continue for the permitted mining. The COE should commit to such process continuance with appropriate monitoring in its ROD.

Overall, EPA believes that our remaining project issues with the proposed mining continuation at Aurora can be successfully resolved within the brackets of these comments and the S33 and "Modified Alternative L" alternatives. We stand ready to further discuss these comments and alternatives. However, if our remaining issues are not adequately resolved, EPA reserves the right to take further action on this project in accordance with its authority under Section 404 of the CWA.

Thank you for the opportunity to comment on the FEIS. If we can be of further assistance, please do not hesitate to contact me at (404) 562-9611 or mueller.heinz@epa.gov. We request a copy of the COE's prospective ROD for our files. For technical questions on wetlands and economics, please contact Becky Fox at (828) 497-3531 or fox.rebecca@epa.gov.

Sincerely,

Heinz J. Mueller, Chief
NEPA Program Office
Office of Policy and Management

Enclosure: *Detailed Comments*

# DETAILED COMMENTS

EPA offers the following comments on selected COE responses to our NEPA, Wetlands Regulatory Section and Regional Administrator letters on the proposed PCS mine continuation project. Additional comments on other topics are also provided.

## COE RESPONSE TO COMMENTS

### I. EPA NEPA Letter on DEIS – 2/9/07

*** R3 (Alternative AP and L Impacts)**

The EPA comment states that the AP alternative would represent the largest permitted loss of waters in North Carolina. This is still true for the Applicant's Proposed Action in the FEIS, Alternative L.

*** R5, 6, 7 and 13 (Economic Practicability Evaluation)**

An appropriate method to evaluate practicability is by calculating the annual discounted net present value (NPV) of the stream of costs and revenues over the lifespan of each alternative. Discounting renders costs and benefits that occur in different time periods comparable by expressing their values in present terms. In practice, discounting is accomplished by multiplying expected future monetary amounts by a discount factor. Such factor reflects time preferences, similar to an interest rate.[2]

For this project, NPV may be calculated very simply by first comparing the annual expected per unit (or ton) cost of phosphate production (mining, mitigation, reclamation, etc.) to the annual expected per unit (or ton) revenue (*i.e.*, the projected USGS value per phosphate ton estimates) for each year in the project. The annual differences between costs and revenues for each alternative may then be combined with estimates of annual

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[2] For example, one would expect $1 put in a savings account with a 5% interest rate today to be worth $1.05 next year. Theoretically, knowing this, a person should be indifferent between being given $1 today or $1.05 in a year. The discounted or net present value of a $1.05 a year from now in this example is therefore $1.

The net present value of a projected stream of current and future benefits and costs is estimated by multiplying the benefits and costs in each year by a time-dependent weight, $d$, and adding all of the weighted values as shown in the following equation:

$$\text{NPV} = NB_0 + d_1 NB_1 + d_2 NB_2 + \ldots + d_n NB_n$$

where $NB_t$ is the net difference between benefits and costs ($B_t$ - $C_t$) that accrue at the end of period (or year in this case) $t$. The discounting weights, $d_t$, are given by

$$d_t = 1/(1+r)^t$$

where $r$ is the discount rate. The final period of the policy's future effects is designated as time $n$.

tons of phosphate produced for each alternative to determine the annual costs and revenues. Finally, using a standard discount rate, the discounted NPV of the streams of annual costs and revenues can be determined over the life of an alternative. Using the discounted NPV, projects of different lengths can be compared on equal terms.

EPA (NCEE) prepared the following summary table using OMB mandated discounted rates of 3 percent and 7 percent to demonstrate this method and NPVs for the FEIS alternatives. Because it allows for more total acres mined in similar locations, "Modified Alternative L" would almost certainly fall on this table above the SCRA alternative. EPA is available to discuss information concerning this summary table and how it was prepared.

**NET PRESENT VALUE OF EACH ALT**

| | 3% | 7% |
|---|---|---|
| EAPA | $537,695,130 | $359,773,753 |
| EAPB | $494,254,356 | $335,778,624 |
| ALT M | $457,571,214 | $328,592,452 |
| ALT L | $370,782,148 | $278,777,886 |
| AP | $370,653,570 | $282,757,722 |
| SJAB | $366,884,793 | $255,241,110 |
| SJAA | $359,076,689 | $274,240,083 |
| SCRA | $333,406,793 | $259,781,521 |
| SCRB | $304,200,087 | $238,057,997 |
| DL1B | $225,807,683 | $161,206,026 |
| S33AP | $130,534,890 | $128,544,556 |
| No Action | -$9,332,194 | $11,700,463 |

* **<u>R8, R10 and R12 (Mitigation Costs)</u>**

The mitigation costs used in the economic model described in the Summarized Comment Response 10 are somewhat confusing. In one place, it states mitigation costs were $5,000/acre for non-brackish marsh wetlands and $205/linear foot of stream with an average stream mitigation ratio of 1:1. Later in this section, the numbers cited are $9,000/acre for wetland and $245/linear foot for streams with a 1.5:1 stream ratio. The current fees (updated July 1, 2008) for the North Carolina Ecosystem Enhancement Program's (EEP) in lieu fee mitigation program are $15,396 for nonriverine wetlands, $30,790 for riverine wetlands and $258/linear foot for streams. The average stream mitigation ratio proposed for project impacts is stated in the FEIS (Section 4.3.2.3.4.2 *Mitigation Ratios*) as 1.8:1. Although we understand the actual mitigation costs used may vary from EEP fees due to the factors discussed by the COE in Summarized Response 10, it is still unclear from the discussion as to which costs were used in the model. We recommend that the economic model be run again with the correct mitigation cost estimates.

* **R9 (Out of Cataloging Unit (CU) Mitigation Ratios)**

We acknowledge the information in the COE's response. However, the NC Interagency Review Team (IRT) is currently revising the out of CU guidance and the IRT will likely adopt some form of the referenced guidance in the near future. As "guidance," it allows for flexibility, including determining out of CU ratios on a case-by-case basis. However, we continue to recommend that this guidance be a starting point when determining mitigation ratios for compensation in a CU different from the CU where the impacts will occur.

* **R11 (Stream Mitigation Costs)**

We are aware that the costs of stream mitigation cannot be directly determined from the NC Stream Mitigation Guidelines (SMG). In our comment, we were not suggesting that to be the case. Instead, EPA intended to point out that the SMG document should be used to determine the amount of linear feet of stream compensation required based on the length and quality of stream being impacted, which then can be used to determine overall cost based on cost/linear foot.

* **R26 (Further Reduction of Environmental Impacts)**

We believe that project impacts can be further reduced by the "environmentally preferable" S33 Alternative and by the modification of Alternative L into "Modified Alternative L," as discussed in the cover letter. We also reference the discussion of the above EPA (NCEE) economic analysis of economic practicability (see EPA comments for R5, 6, 7 and 13).

**II. EPA NEPA Letter on DSEIS – 12/28/07**

* **R2, R4, R7 (Economic Practicability Evaluation Topic)**

See EPA's above comments to Section I for R5, R6, R7 and R13.

* **R6 (Alternative L – South 33 Impacts)**

The COE's response does not clarify why the mining boundary for S33 was expanded from the SCR boundary for mining in S33. The SCR boundary was developed with the goal of avoiding, to the maximum extent possible, important aquatic resources. We found no support in the FEIS for a determination that a more expansive mining boundary than SCR in the S33 tract is needed for Alternative L to be economically practicable.

*** R8, R9, R10, R16, R17, R18 (Bonnerton SNHA)**

As indicated in the cover letter and in EPA's April 30, 2008 letter, and as acknowledged by the COE in these responses, the NHP has designated the Bonnerton SNHA as "nationally significant." Such designation reinforces the need to preserve the entire SNHA tract, the community type represented, and the contiguous nature of the SNHA. The "nationally significant" designation of the Bonnerton nonriverine wetland hardwood forest SNHA means the NHP considers this area to one of the five best examples of this community type in the nation. The size and maturity of this area are critical to the NHP rating.

*** R11, R12 (Reopener Clause)**

EPA reiterates the concerns stated in our DSEIS letter for the potential economic reopener clause and recommends that the reopener clause, or other suitable measures, remain an option for future adaptive management needs. As you are aware, the FEIS did not include a detailed mitigation plan for S33 impacts. The Applicant would need to address unavoidable and unminimizable impacts well in advance of planned mining into this tract. The economic reopener clause may be the appropriate vehicle to effectuate this action.

### III. EPA Wetlands Regulatory Section Letter on CWA Section 404(q), Part IV, Paragraph 3(a) – 2/9/07

*** R1, R6, R8, R9, R12, R13, R16 and R17 (CWA Section 404 (q) and Compliance with 404 (b)(1) Guidelines)**

EPA supports the COE's position that there are less environmentally damaging practicable alternatives than the AP/EAP alternatives. We appreciate the Applicant for changing its request from these alternatives to the L alternative. However, as stated in the cover letter, we believe the S33AP Alternative is the NEPA "environmentally preferable alternative" and that Alternative L could be improved environmentally as "Modified Alternative L". Overall, EPA considers "Modified Alternative L" to be an economically practicable and environmentally reasonable alternative that is more environmentally preferable than Alternative L.

*** R5 (Impacts to Fisheries Habitats)**

EPA acknowledges the COE's response. We defer to the state and federal marine and wildlife agencies for more in depth comments on fisheries habitats impacted and avoided. However, we believe the COE's response could be misleading in its enumeration of bottomland hardwood wetland and stream impacts, as these refer to NCPC tract impacts and not project impacts as a whole which are greater.

**IV. EPA Regional Administrator Letter on CWA Section 404(q), Part IV, Paragraph 3(b) – 3/6/07**

*** R3, R4 and R5 (CWA Section 404 (q) and Compliance with 404 (b)(1) Guidelines)**

See EPA's above comments to Section III for R1, R6, R8, R9, R12, R13, R16 and R17.

**OTHER COMMENTS**

*** Silviculture** – We hereby reiterate the following comments which were included in our April 30, 2008, pre-FEIS letter.

"EPA maintains that logging an area by a permit applicant where there is an intent to mine the same area after the completion of the logging operation, by the same applicant would remove the activity from the silviculture exemption. As the 404 regulations state (40 CFR 232.3 (b)), any discharge of dredged or fill material into waters of the U.S., must have a permit if it is part of an activity whose purpose is to convert an area of waters of the U.S. into a use which it was not previously subject and where the flow or circulation of waters may be impaired or the reach of such waters reduced. EPA maintains this applies to a logging and road construction operation in an area where the future proposed use is a phosphate mining operation. It is our position that it would be difficult to log this area without a discharge of fill material and thus would require a 404 permit for the site preparation and the future mining operation as one permitted action."

*** TMDLs** – Segments of the Pamlico River in the vicinity of the PCS Phosphates facility are currently listed (or proposed for listing) as impaired waterbodies under Section 303(d) of CWA. The identified pollutant of concern is Chlorophyll-*a*, which triggers the need for development of Total Maximum Daily Loads (TMDLs) for the nutrients Total Phosphorus (TP) and Total Nitrogen (TN). These TMDLs, developed after comprehensive studies by the state, will be approved by EPA Region 4. The studies will include a detailed "source assessment" of existing and potential sources of TN and TP, and ultimately will set limits for both Point and Nonpoint sources, including all stormwater discharges.

These nutrients TMDLs thus have the potential to affect and possibly limit future mining related discharges into the impaired receiving waters. Besides the nutrient Phosphorus, Page 4-100 of the FEIS indicates that there are a limited number of other water quality parameters that will be of potential concern from reclaimed areas, including Fluoride, Suspended Solids and Metals. These other water quality parameters should be fully monitored to ensure continued compliance with the State of North Carolina's current Water Quality Standards (WQS). It is anticipated by EPA Region 4 that only Total Phosphorus (TP) and Total Nitrogen (TN) will actually be addressed by a TMDL in the near future. This is because the Pamlico River in this is area is currently only listed for Chlorophyll-*a*, an indicator of nutrient enrichment, and is not listed as impaired for any

other pollutant. If the Pamlico River segments downstream of the PCS facility are ever listed for any other pollutants besides Chlorophyll-*a*, then TMDLs will need to be developed for each pollutant.

We are aware that monitoring is being conducted as part of the Applicant's existing National Pollutant Discharge Elimination (NPDES) permit and that pollutant concentrations in existing stormwater runoff appear to be relatively low for the ongoing mining, although the operation is not a zero-discharge facility. We understand that after on-site stormwater at PCS Phosphates meets a certain water quality, it will no longer enter the plant site recycle system, but instead will be directed either to the Pamlico River (through the NPDES permitted and monitored Outfalls 009 or 101) or allowed to re-enter the individual creek systems.

Therefore, while nutrient discharges are not currently a major concern, the Applicant should be advised that once the State develops nutrient TMDLs and EPA Region 4 approves those TMDLs, the existing and proposed mining activities will need to be compliant with those daily load limitations for the impaired segments of the Pamlico River and its tributaries.

* **EFH** – EPA will defer to the state and federal marine and wildlife agencies regarding mining impacts to Essential Fish Habitat (EFH). However, the Applicant should consider EFH in the avoidance and minimization process, as it relates to minimizing the loss of habitat that is essential to local fish species.

# Exhibit 2

United States
Environmental Protection
Agency

PB85-227049

# Guidelines for Deriving Numerical National Water Quality Criteria for the Protection Of Aquatic Organisms and Their Uses

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## *Notices*

This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication.

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This document is available the public to through the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161.

### Special Note

This December 2010 electronic version of the 1985 Guidelines serves to meet the requirements of Section 508 of the Rehabilitation Act. While converting the 1985 Guidelines to a 508-compliant version, EPA updated the taxonomic nomenclature in the tables of Appendix 1 to reflect changes that occurred since the table were originally produced in 1985. The numbers included for Phylum, Class and Family represent those currently in use from the Integrated Taxonomic Information System, or ITIS, and reflect what is referred to in ITIS as Taxonomic Serial Numbers. ITIS replaced the National Oceanographic Data Center (NODC) taxonomic coding system which was used to create the original taxonomic tables included in the 1985 Guidelines document (NODC, Third Addition - see Introduction). For more information on the NODC taxonomic codes, see http://www.nodc.noaa.gov/General/CDR-detdesc/taxonomic-v8.html.

The code numbers included in the reference column of the tables have not been updated from the 1985 version. These code numbers are associated with the old NODC taxonomic referencing system and are simply replicated here for historical purposes. Footnotes may or may not still apply.

EPA is working on a more comprehensive update to the 1985 Guidelines, including new taxonomic tables which better reflect the large number of aquatic animal species known to be propagating in U.S. waters.

## *Table of Contents*


Notices ii
Table of Contents iii
Executive Summary iv
Figure 1 v
Introduction 1
I. Definition of Material of Concern 9
II. Collection of Data 11
III. Required data 11
IV. Final Acute Value 14
V. Final Acute Equation 17
VI. Final Chronic Value 19
VII. Final Chronic Equation 22
VIII. Final Plant Value 25
IX. Final Residue Value 25
X. Other Data 28
XI. Criterion 28
XII. Final Review 29
References 31
Appendix 1. Resident North American Species of Aquatic Animals Used in Toxicity and Bioconcentation Tests 33
Introduction 33
Freshwater Species Table 34
Footnotes for Freshwater Species 42
References for Freshwater Species 43
Saltwater Species Table 45
Footnotes for Saltwater Species 51
References for Saltwater Species 51
Appendix 2. Example Calculation of Final Acute Value, Computer Program, and Printouts 53
A. Example Calculation 53
B. Example Computer Program in BASIC Language for Calculating the FAV 53
C. Example Printouts from Program 54

## Executive Summary

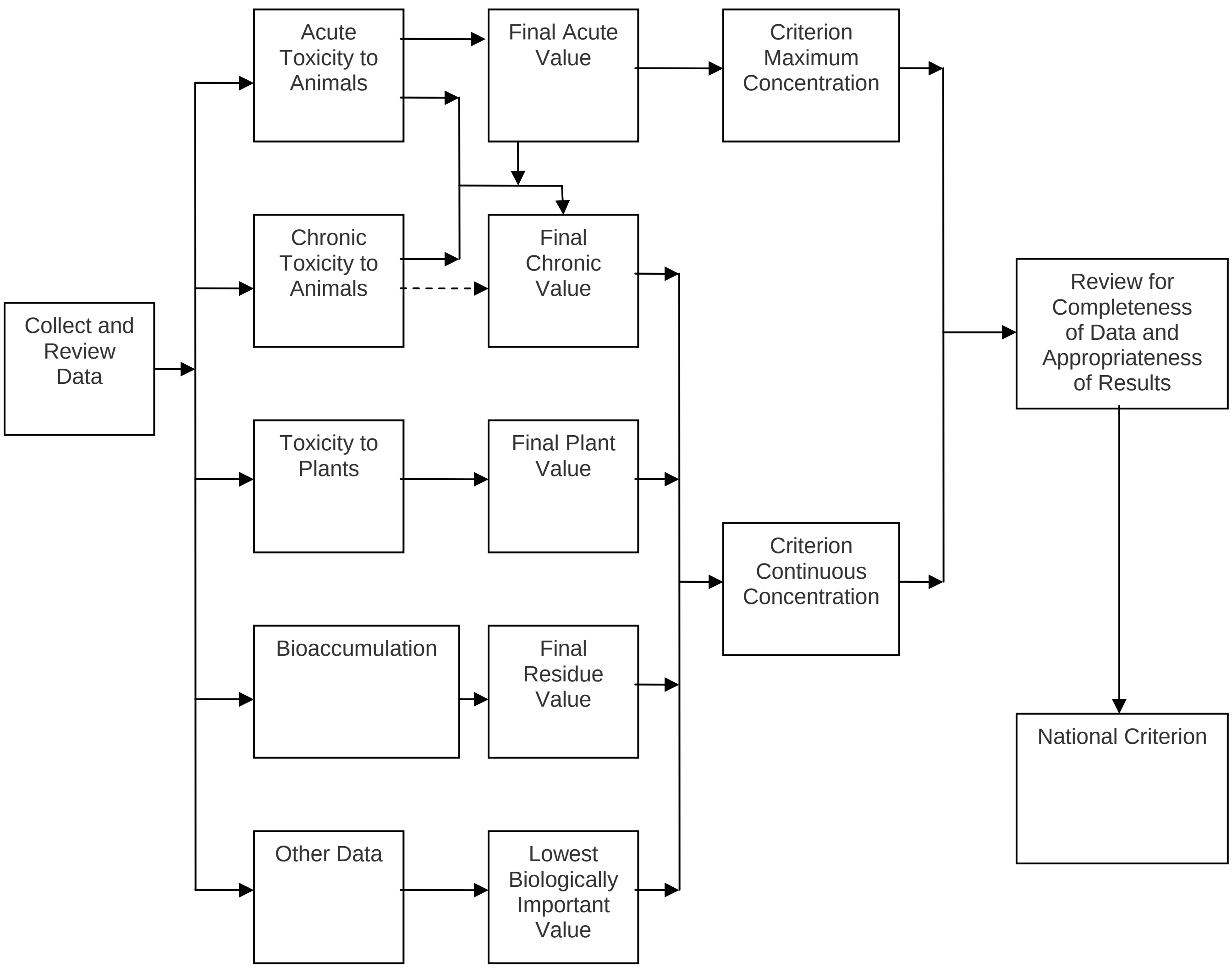
Derivation of numerical national water quality criteria for the protection of aquatic organism and their uses is a complex process (Figure 1) that uses information from many areas of aquatic toxicology. After a decision is made that a national criterion is needed for a particular material, all available information concerning toxicity to, and bioaccumulation by, aquatic organisms is collected, reviewed for acceptability, and sorted. If enough acceptable data on acute toxicity to aquatic animals are available, they are used to estimate the highest one-hour average concentration that should not result in unacceptable effects on aquatic organisms and their uses. If justified, this concentration is made a function of a water quality characteristic such as pH, salinity, or hardness. Similarly, data on the chronic toxicity of the material to aquatic animals are used to estimate the highest four-daily average concentration that should not cause unacceptable toxicity during a long-term exposure. If appropriate, this concentration is also related to a water quality characteristic.

Data on toxicity to aquatic plants are examined to determine whether plants are likely to be unacceptably affected by concentrations that should not cause unacceptable effects on animals. Data on bioaccumulation by aquatic organisms are used to determine if residues might subject edible species to restrictions by the U.S. Food and Drug Administration or if such residues might harm some wildlife consumers of aquatic life. All other available data are examined for adverse effects that might be biologically important.

If a thorough review of the pertinent information indicates that enough acceptable data are available, numerical national water quality criteria are derived for fresh water or salt water or both to protect aquatic organisms and their uses from unacceptable effects due to exposures to high concentrations for short periods of time, lower concentrations for longer periods of time, and combinations of the two.

***Figure 1***

Derivation of Numerical National Water Quality Crtieria for the Protection of Aquatic Organisms and Their Uses



## Introduction

Of the several possible forms of criteria, the numerical form is the most common, but the narrative (e.g., pollutants must not be present in harmful concentrations) and operational (e.g., concentrations of pollutants must not exceed one-tenth of the 96-hr LC50) forms can be used if numerical criteria are not possible or desirable. If it were feasible, a freshwater (or saltwater) numerical aquatic life national criterion* for a material should be determined by conducting field tests on a wide variety of unpolluted bodies of fresh (or salt) water. It would be necessary to add various amounts of the material to each body of water in order to determine the highest concentration that would not cause any unacceptable long-term or short-term effect on the aquatic organisms or their uses. The lowest of these highest concentrations would become the freshwater (or saltwater) national aquatic life water quality criterion for that material, unless one or more of the lowest concentrations were judged to be outliers. Because it is not feasible to determine national criteria by conducting such field tests, these Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses (hereafter referred to as the National Guidelines) describe an objective, internally consistent, appropriate, and feasible way of deriving national criteria, which are intended to provide the same level of protection as the infeasible field testing approach described above.

Because aquatic ecosystems can tolerate some stress and occasional adverse effects, protection of all species at all times and places is not deemed necessary. If acceptable data are available for a large number of appropriate taxa from an appropriate variety of taxonomic and functional groups, a reasonable level of protection will probably be provided if all except a small fraction of the taxa are protected, unless a commercially or recreationally important species is very sensitive. The small fraction is set at 0.05 because other fractions resulted in criteria that seemed too high or too low in comparison with the sets of data from which they were calculated. Use of 0.05 to calculate a Final Acute Value does not imply that this percentage of adversely affected taxa should be used to decide in a field situation whether a criterion is too high or too low or just right.

Determining the validity of a criterion derived for a particular body of water, possibly by modification of a national criterion to reflect local conditions [1, 2, 3], should be based on an operation definition of "protection of aquatic organisms and their uses" that takes into account the practicalities of field monitoring programs and the concerns of the public. Monitoring programs should contain sampling points at enough times and places that all unacceptable changes, whether caused directly or indirectly, will be detected. The programs should adequately monitor the kinds of species of concern to the public, i.e., fish in fresh water and fish and macroinvertebrates in salt water. If the kinds of species of concern cannot be adequately monitored at a reasonable cost, appropriate surrogate species should be monitored. The kinds of species most likely to be good surrogates are those that either (a) are a major food of the desired kinds of species or (b) utilize the same food as the desired species or (c) both. Even if a major adverse effect on appropriate surrogate species does not directly result in an unacceptable effect on the kinds of species of concern to the public, it indicates a high probability that such an effect will occur.

---

* The term "national criteria" is used herein because it is more descriptive than the synonymous term "section 304(a) criteria", which is used in the Water Quality Standards Regulation [1].

To be acceptable to the public and useful in field situations, protection of aquatic organisms and their uses should be defined as prevention of unacceptable long-term short-term effects on (1) commercially, recreationally, and other important species and (2) (a) fish and benthic invertebrate assemblages in rivers and streams, and (b) fish, benthic invertebrate, and zooplankton assemblages in lakes, reservoirs, estuaries, and oceans. Monitoring programs intended to be able to detect unacceptable effects should be tailored to the body of water of concern so that necessary samples are obtained at enough times and places to provide adequate data on the populations of the important species, as well as data directly related to the reasons for their being considered important. For example, for substances that are residue limited, species that are consumed should be monitored for contaminants to ensure that wildlife predators are protected, FDA action levels are not exceeded, and flavor is not impaired. Monitoring programs should also provide data on the number of taxa and number of individuals in the above-named assemblages that can be sampled at reasonable cost. The amount of decrease in the number of taxa or number of individuals in an assemblage that should be considered unacceptable should take into account appropriate features of the body of water and its aquatic community. Because most monitoring programs can only detect decreases of more than 20 percent, any statistically significant decrease should usually be considered unacceptable. The insensitivity of most monitoring programs greatly limits their usefulness for studying the validity of criteria because unacceptable changes can occur and not be detected. Therefore, although limited field studies can sometimes demonstrate that criteria are underprotective, only high quality field studies can reliably demonstrate that criteria are not underprotective.

If the purpose of water quality criteria were to protect only commercially and recreationally important species, criteria specifically derived to protect such species and their uses from the direct adverse effects of a material would probably, in most situations, also protect those species from indirect adverse effects due to effects of the material on other species in the ecosystem. For example, in most situations either the food chain would be more resistant than the important species and their uses or the important species and their food chains would be adaptable enough to overcome effects of the material on portions of the food chains.

These National Guidelines have been developed on the theory that effects which occur on a species in appropriate laboratory tests will generally occur on the same species in comparable field situations. All North American bodies of water and resident aquatic species and their uses are meant to be taken into account, except for a few that may be too atypical, such as the Great Salt Lake, brine shrimp, and the siscowet subspecies of lake trout, which occurs in Lake Superior and contains up to 67% fat in the fillets [4]. Derivation of criteria specifically for the Great Salt Lake or Lake Superior might have to take brine shrimp and siscowet, respectively, into account.

Numerical aquatic life criteria derived using these National Guidelines are expressed as two numbers, rather than the traditional one number, so that the criteria more accurately reflect toxicological and practical realities. If properly derived and used, the combination of a maximum concentration and a continuous concentration should provide an appropriate degree of protection of aquatic organisms and their uses from acute and chronic toxicity to animals, toxicity to plants, and bioaccumulation by aquatic organisms, without being as restrictive as a one-number criterion would have to be in order to provide the same degree of protection.

Criteria produced by these Guidelines are intended to be useful for developing water quality standards, mixing zone standards, effluent limitations, etc. The development of such standards

and limitations, however, might have to take into account such additional factors as social, legal, economic, and hydrological considerations, the environmental and analytical chemistry of the material, the extrapolation from laboratory data to field situations, and relationships between species for which data are available and species in the body of water of concern. As an intermediate step in the development of standards, it might be desirable to derive site-specific criteria by modification of national criteria to reflect such local conditions as water quality, temperature, or ecologically important species [1, 2. 3]. In addition, with appropriate modifications these National Guidelines can be used to derive criteria for any specific geographical area, body of water (such as the Great Salt Lake), or group of similar bodies of water, if adequate information is available concerning the effects of the material of concern on appropriate species and their uses.

Criteria should attempt to provide a reasonable and adequate amount of protection with only a small possibility of considerable overprotection or underprotection. It is not enough that a national criterion be the best estimate that can be obtained using available data; it is equally important that a criterion be derived only if adequate appropriate data are available to provide reasonable confidence that it is a good estimate. Therefore, these National Guidelines specify certain data that should be available if a numerical criterion is to be derived. If all the required data are not available, usually a criterion should not be derived. On the other hand, the availability of all required data does not ensure that a criterion can be derived.

A common belief is that national criteria are based on "worst case" assumptions and that local considerations will raise, but not lower, criteria. For example, it will usually be assumed that if the concentration of a material in a body of water is lower than the national criterion, no unacceptable effects will occur and no site-specific criterion needs to be derived. If, however, the concentration of a material in a body of water is higher than the national criterion, it will usually be assumed that a site-specific criterion should be derived. In order to prevent the assumption of the "worst case" nature of national criteria from resulting in the underprotection of too many bodies of water, national criteria must be intended to protect all or almost all bodies of water. Thus, if bodies of water and the aquatic communities in them do differ substantially in their sensitivities to a material, national criteria should be at least somewhat overprotective for a majority of the bodies of water. To do otherwise would either (a) require derivation of site-specific criteria even if the site-specific concentration were substantially below the national criterion or (b) cause the "worst case" assumption to result in the underprotection of numerous bodies of water. On the other hand, national criteria are probably underprotective of some bodies of water.

The two factors that will probably cause the most difference between national and site-specific criteria are the species that will be exposed and the characteristics of the water. In order to ensure that national criteria are appropriately protective, the required data for national criteria include some species that are sensitive to many materials and national criteria are specifically based on tests conducted in water relatively low in particulate matter and organic matter. Thus, the two factors that will usually be considered in the derivation of site-specific criteria from national criteria are used to help ensure that national criteria are appropriately protective.

On the other hand, some local conditions might require that site-specific criteria be lower than national criteria. Some untested locally important species might be very sensitive to the material of concern, and local water quality might not reduce the toxicity of the material. In addition,

aquatic organisms in field situations might be stressed by diseases, parasites, predators, other pollutants, contaminated or insufficient food, and fluctuating and extreme conditions of flow, water quality, and temperature. Further, some materials might degrade to more toxic materials, or some important community functions or species interactions might be adversely affected by concentrations lower than those that affect individual species.

Criteria must be used in a manner that is consistent with the way in which they were derived if the intended level of protection is to be provided in the real world. Although derivation of water quality criteria for aquatic life is constrained by the ways toxicity and bioconcentration tests are usually conducted, there are still many different ways that criteria can be derived, expressed, and used. The means used to derive and state criteria should relate, in the best possible way, the kinds of data that are available concerning toxicity and bioconcentration and the ways criteria can be used to protect aquatic organisms and their uses.

The major problem is to determine the best way that the statement of a criterion can bridge the gap between the nearly constant concentrations used in most toxicity and bioconcentration tests and the fluctuating concentrations that usually exist in the real world. A statement of a criterion as a number that is not to be exceeded any time or place is not acceptable because few, if any, people who use criteria would take it literally and few, if any, toxicologists would defend a literal interpretation. Rather than try to reinterpret a criterion that is neither useful nor valid, it is better to develop a more appropriate way of stating criteria.

Although some materials might not exhibit thresholds, many materials probably do. For any threshold material, continuous exposure to any combination of concentrations below the threshold will not cause an unacceptable effect (as defined on pages 1 and 2) on aquatic organisms and their uses, except that the concentration of a required trace nutrient might be too low. However, it is important to note that this is a threshold of unacceptable effect, not a threshold of adverse effect. Some adverse effect, possibly even a small reduction in the survival, growth, or reproduction of a commercially or recreationally important species, will probably occur at, and possibly even below, the threshold. The Criterion Continuous Concentration (CCC) is intended to be a good estimate of this threshold of unacceptable effect. If maintained continuously, any concentration above the CCC is expected to cause an unacceptable effect. On the other hand, the concentration of a pollutant in a body of water can be above the CCC without causing an unacceptable effect if (a) the magnitudes and durations of the excursions above the CCC are appropriately limited and (b) there are compensating periods of time during which the concentration is below the CCC. The higher the concentration is above the CCC, the shorter the period of time it can be tolerated. But it is unimportant whether there is any upper limit on concentrations that can be tolerated instantaneously or even for one minute because concentrations outside mixing zones rarely change substantially in such short periods of time.

An elegant, general approach to the problem of defining conditions (a) and (b) would be to integrate the concentration over time, taking into account uptake and depuration rates, transport within the organism to a critical site, etc. Because such an approach is not currently feasible, an approximate approach is to require that the average concentration not exceed the CCC. The average concentration should probably be calculated as the arithmetic average rather than the geometric mean [5]. If a suitable averaging period is selected, the magnitudes and durations of concentrations above the CCC will be appropriately limited, and suitable compensating periods below the CCC will be required.

In the elegant approach mentioned above, the uptake and depuration rates would determine the effective averaging period, but these rates are likely to vary from species to species for any particular material. Thus the elegant approach might not provide a definitive answer to the problem of selecting an appropriate averaging period. An alternative is to consider that the purpose of the averaging period is to allow the concentration to be above the CCC only if the allowed fluctuating concentrations do not cause more adverse effect than would be caused by a continuous exposure to the CCC. For example, if the CCC caused a 10% reduction in growth of rainbow trout, or a 13% reduction in survival of oysters, or a 7% reduction in reproduction of smallmouth bass, it is the purpose of the averaging period to allow concentrations above the CCC only if the total exposure will not cause any more adverse effect than continuous exposure to the CCC would cause.

Even though only a few tests have compared the effects of a constant concentration with the effects of the same average concentration resulting from a fluctuating concentration, nearly all the available comparisons have shown that substantial fluctuations result in increased adverse effects [5, 6]. Thus if the averaging period is not to allow increased adverse effects, it must not allow substantial fluctuations. Life-cycle tests with species such as mysids and daphnids and early life-stage tests with warmwater fishes usually last for 20 to 30 days. An averaging period that is equal to the length of the test will obviously allow the worst possible fluctuations and would very likely allow increased adverse effects.

An averaging period of four days seems appropriate for use with the CCC for two reasons. First, it is substantially shorter than the 20 to 30 days that is obviously unacceptable. Second, for some species it appears that the results of chronic tests are due to the existence of a sensitive life stage at some time during the test [7], rather than being caused by either long-term stress or long-term accumulation of the test material in the organism. The existence of a sensitive life stage is probably the cause of acute-chronic ratios that are not much greater than 1, and is also possible when the ratio is substantially greater than 1. In addition, some experimentally determined acute-chronic ratios are somewhat less than 1, possibly because prior exposure during the chronic test increased the resistance of the sensitive life stage [8]. A four-day averaging period will probably prevent increased adverse effects on sensitive life stages by limiting the durations and magnitudes of exceedences[*] of the CCC.

The considerations applied to interpretation of the CCC also apply to the CMC. For the CMC the averaging period should again be substantially less than the lengths of the tests it is based on, i.e., substantially less than

48 to 96 hours. One hour is probably an appropriate averaging period because high concentrations of some materials can cause death in one to three hours. Even when organisms do not die within the first hour or so, it is not known how many might have died due to delayed effects of this short of an exposure. Thus it is not appropriate to allow concentrations above the CMC to exist for as long as one hour.

The durations of the averaging periods in national criteria have been made short enough to restrict allowable fluctuations in the concentration of the pollutant in the receiving water and to restrict the length of time that the concentration in the receiving water can be continuously above

[*] Although "exceedence" has not been found in any dictionary, it is used here because it is not appropriate to use "violation" in conjunction with criteria, no other word seems appropriate, and all appropriate phrases are awkward.

a criterion concentrations. The statement of a criterion could specify that the four-day average should never exceed the CCC and that the one-hour average should never exceed the CMC. However, one of the most important uses of criteria is for designing waste treatment facilities. Such facilities are designed based on probabilities and it is not possible to design for a zero probability. Thus, one of the important design parameters is the probability that the four-day average or the one-hour-average will be exceeded, or, in other words, the frequency with which exceedences will be allowed.

The frequency of allowed exceedences should be based on the ability of aquatic ecosystems to recover from the exceedences, which will depend in part on the magnitudes and durations of the exceedences. It is important to realize that high concentrations caused by spills and similar major events are not what is meant by an "exceedence", because spills and other accidents are not part of the design of the normal operation of waste treatment facilities. Rather, exceedences are extreme values in the distribution of ambient concentrations and this distribution is the result of the usual variations in the flows of both the effluent and the receiving water and the usual variations in the concentrations of the material of concern in both the effluent and in the upstream receiving water. Because exceedences are the result of usual variation, most of the exceedences will be small and exceedences as large as a factor of two will be rare. In addition, because these exceedences are due to random variation, they will not be evenly spaced. In fact, because many receiving waters have both one-year and multi-year cycles and many treatment facilities have daily, weekly, and yearly cycles, exceedences will often be grouped, rather than being evenly spaced or randomly distributed. If the flow of the receiving water is usually much greater than the flow of the effluent, normal variation and the flow cycles will result in the ambient concentration usually being below the CCC, occasionally being near the CCC, and rarely being above the CCC. In addition, exceedences that do occur will be grouped. On the other hand, if the flow of the effluent is much greater than the flow of the receiving water, the concentration might be close to the CCC much of the time and rarely above the CCC, with exceedences being randomly distributed.

The abilities of ecosystems to recover differ greatly, and depend on the pollutant, the magnitude and duration of the exceedence, and the physical and biological features of the ecosystem. Documented studies of recoveries are few, but some systems recover from small stresses in six weeks whereas other systems take more than ten years to recover from severe stress [3]. Although most exceedences are expected to be very small, larger exceedences will occur occasionally. Most aquatic ecosystems can probably recover from most exceedences in about three years. Therefore, it does not seem reasonable to purposely design for stress above that caused by the CCC to occur more than once every three years on the average, just as it does not seem reasonable to require that these kinds of stresses only occur once every five or ten years on the average.

If the body of water is not subject to anthropogenic stress other than the exceedences of concern and if exceedences as large as a factor of two are rare, it seems reasonable that most bodies of water could tolerate exceedences once every three years on the average. In situations in which exceedences are grouped, several exceedences might occur in one or two years, but then there will be, for example, 10 to 20 years during which no exceedences will occur and the concentration will be substantially below the CCC most of the time. In situations in which the concentration is often close to the CCC and exceedences are randomly distributed, some adverse effect will occur regularly, and small additional, unacceptable effects will occur about every

third year. The relative long-term ecological consequences of evenly spaced and grouped exceedences are unknown, but because most exceedences will probably be small, the long-term consequences should be about equal over long periods of time.

The above considerations lead to a statement of a criterion in the frequency-intensity-duration format that is often used to describe rain and snow fall and stream flow, e.g., how often, on the average, does more than ten inches of rain fall in a week? The numerical values chosen for frequency (or average recurrence interval), intensity (i.e., concentration), and duration (of averaging period) are those appropriate for national criteria. Whenever adequately justified, a national criterion may be replaced by a site-specific criterion [1], which may include not only site-specific criterion concentrations [2], but also site-specific durations of averaging periods and site-specific frequencies of allowed exceedences [3].

The concentrations, durations, and frequencies specified in criteria are based on biological, ecological, and toxicological data, and are designed to protect aquatic organisms and their uses from unacceptable effects. Use of criteria for designing waste treatment facilities requires selection~~s~~ of an appropriate wasteload allocation model. Dynamic models are preferred for the application of water quality criteria, but a steady-state model might have to be used instead of a dynamic model in some situations. Regardless of the model that is used, the durations of the averaging periods and the frequencies of allowed exceedences must be applied correctly if the intended level of protection is to be provided. For example, in the criterion statement frequency refers to the average frequency, over a long period of time, of rare events (i.e., exceedences). However, in some disciplines, frequency is often thought of in terms of the average frequency, over a long period of time, of the years is which rare events occur, without any consideration of how many rare events occur within each of those eventful years. The distinction between the frequency of events and the frequency of years in important for all those situations in which the rare events, e.g., exceedences, tend to occur in groups within the eventful years. The two ways of calculating frequency produce the same results in situations in which each rare event occurs in a different year because then the frequency of events is the same as the frequency of eventful years.

Because fresh water and salt water have basically different chemical compositions and because freshwater and saltwater (i.e., estuarine and true marine) species rarely inhabit the same water simultaneously, these National Guidelines provide for the derivation of separate criteria for these two kinds of water. For some materials sufficient data might not be available to allow derivation of criteria for one or both kinds of water. Even though absolute toxicities might be different in fresh and salt waters, such relative data as acute-chronic ratios and bioconcentration factors often appear to be similar in the two waters. When data are available to indicate that these ratios and factors are probably similar, they are used interchangeably.

The material for which a criterion is desired is usually defined in terms of a particular chemical compound or ion, or a group of closely related compounds or ions, but it might possibly be defined in terms of an effluent. These National Guidelines might also be useful for deriving criteria for temperature, dissolved oxygen, suspended solids, pH, etc., if the kinds of data on which the Guidelines are based are available.

Because they are meant to be applied only after a decision has been made that a national water quality criterion for aquatic organisms is needed for a material, these National Guidelines do not

address the rationale for making that decision. If the potential for adverse effects on aquatic organisms and their uses is part of the basis for deciding whether an aquatic life criterion is needed for a material, these Guidelines will probably be helpful in the collection and interpretation of relevant data. Such properties as volatility might affect the fate of a material in the aquatic environment and might be important when determining whether a criterion is needed for a material; for example, aquatic life criteria might not be needed for materials that are highly volatile or highly degradable in water. Although such properties can affect how much of the material will get from the point of discharge through any allowed mixing zone to some portion of the ambient water and can also affect the size of the zone of influence in the ambient water, such properties do not affect how much of the material aquatic organisms can tolerate in the zone of influence.

This version of the National Guidelines provides clarifications, additional details, and technical and editorial changes from the previous version [9]. These modifications are the result of comments on the previous version and subsequent drafts [10], experience gained during the U.S. EPA's use of previous versions and drafts, and advances in aquatic toxicology and related fields. Future versions will incorporate new concepts and data as their usefulness is demonstrated. The major technical changes incorporated into this version of the National Guidelines are:

1. The requirement for acute data for freshwater animals has been changed to include more tests with invertebrate species. The taxonomic, functional, and probably the toxicological, diversities among invertebrate species are greater than those among vertebrate species and this should be reflected in the required data.

2. When available, 96-hr EC50s based on the percentage of fish immobilized plus the percentage of fish killed are used instead of 96-hr LC50s for fish; comparable EC50s are used instead of LC50s for other species. Such appropriately defined EC50s better reflect the total severe acute adverse impact of the test material on the test species than do LC50s or narrowly defined EC50s. Acute EC50s that are based on effects that are not severe, such as reduction in shell deposition and reduction in growth, are not used in calculating the Final Acute Value.

3. The Final Acute Value is now defined in terms of Genus Mean Acute Values rather than Species Mean Acute Values. A Genus Mean Acute Value is the geometric mean of all the Species Mean Acute Values available for species in the genus. On the average, species within a genus are toxicologically much more similar than species in different genera, and so the use of Genus Mean Acute Values will prevent data sets from being biased by an overabundance of species in one or a few genera.

4. The Final Acute Value is now calculated using a method [11] that is not subject to the bias and anomalous behavior that the previous method was. The new method is also less influenced by one very low value because it always gives equal weight to the four values that provide the most information about the cumulative probability of 0.05. Although the four values receive the most weight, the other values do have a substantial effect on the Final Acute Value (see examples in Appendix 2).

5. The requirements for using the results of tests with aquatic plants have been made more stringent.

6. Instead of being equal to the Final Acute Value, the Criterion Maximum Concentration is now equal to one-half the Final Acute Value. The Criterion Maximum Concentration is intended to protect 95 percent of a group of diverse genera, unless a commercially or recreationally important species is very sensitive. However, a concentration that would severely harm 50 percent of the fifth percentile or 50 percent of a sensitive important species cannot be considered to be protective of that percentile or that species. Dividing the Final Acute Value by 2 is intended to result in a concentration that will not severely adversely affect too many of the organisms.

7. The lower of the two numbers in the criterion is now called the Criterion Continuous Concentration, rather than the Criterion Average Concentration, to more accurately reflect the nature of the toxicological data on which it is based.

8. The statement of a criterion has been changed (a) to include durations of averaging periods and frequencies of allowed exceedences that are based on what aquatic organisms and their uses can tolerate, and (b) to identify a specific situation in which site-specific criteria [1, 2, 3] are probably desirable.

In addition, Appendix 1 was added to aid in determining whether a species should be considered resident in North America and its taxonomic classification. Appendix 2 explains the calculation of the Final Acute Value.

The amount of guidance in these National Guidelines has been increased, but much of the guidance is necessarily qualitative rather than quantitative; much judgment will usually be required to derive a water quality criterion for aquatic organisms and their uses. In addition, although this version of the National Guidelines attempts to cover all major questions that have arisen during use of previous versions and drafts, it undoubtedly does not cover all situations that might occur in the future. All necessary decisions should be based on a thorough knowledge of aquatic toxicology and an understanding of these Guidelines and should be consistent with the spirit of these Guidelines, i.e., to make best use of the available data to derive the most appropriate criteria. These National Guidelines should be modified whenever sound scientific evidence indicates that a national criterion produced using these Guidelines would probably be substantially overprotective or underprotective of the aquatic organisms and their uses on a national basis. Derivation of numerical national water quality criteria for aquatic organisms and their uses is a complex process and requires knowledge in many areas of aquatic toxicology; any deviation from these Guidelines should be carefully considered to ensure that it is consistent with other parts of these Guidelines.

## I. Definition of Material of Concern

A. Each separate chemical that does not ionize substantially in most natural bodies of water should usually be considered a separate material, except possibly for structurally similar organic compounds that only exist in large quantities as commercial mixtures of various compounds and apparently have similar biological, chemical, physical, and toxicological properties.

B. For chemicals that do ionize substantially in most natural bodies of water (e.g., some phenols and organic acids, some salts of phenols and organic acids, and most

inorganic salts and coordination complexes of metals), all forms that would be in chemical equilibrium should usually be considered one material. Each different oxidation state of a metal and each different nonionizable covalently bonded organometallic compound should usually be considered a separate material.

C. The definition of the material should include an operational analytical component. Identification of a material simply, for example, as "sodium" obviously implies "total sodium", but leaves room for doubt. If "total" is meant, it should be explicitly stated. Even "total" has different operational definitions, some of which do not necessarily measure "all that is there" in all samples. Thus, it is also necessary to reference or describe the analytical method that is intended. The operational analytical component should take into account the analytical and environmental chemistry of the material, the desirability of using the same analytical method on samples from laboratory tests, ambient water, and aqueous effluents, and various practical considerations, such as labor and equipment requirements and whether the method would require measurement in the field or would allow measurement after samples are transported to a laboratory.

The primary requirements of the operational analytical component are that it be appropriate for use on samples of receiving water, that it be compatible with the available toxicity and bioaccumulation data without making extrapolations that are too hypothetical, and that it rarely result in underprotection or overprotection of aquatic organisms and their uses. Because an ideal analytical measurement will rarely be available, a compromise measurement will usually have to be used. This compromise measurement must fit with the general approach that if an ambient concentration is lower than the national criterion, unacceptable effects will probably not occur, i.e., the compromise measurement must not err on the side of underprotection when measurements are made on a surface water. Because the chemical and physical properties of an effluent are usually quite different from those of the receiving water, an analytical method that is acceptable for analyzing an effluent might not be appropriate for analyzing a receiving water, and vice versa. If the ambient concentration *calculated* from a measured concentration in an effluent is higher than the national criterion, an additional option is to *measure* the concentration after dilution of the effluent with receiving water to determine if the measured concentration is lowered by such phenomena as complexation or sorption. A further option, of course, is to derive a site-specific criterion [1, 2, 3]. Thus, the criterion should be based on an appropriate analytical measurement, but the criterion is not rendered useless if an ideal measurement either is not available or is not feasible.

**NOTE:** The analytical chemistry of the material might have to be taken into account when defining the material or when judging the acceptability of some toxicity tests, but a criterion should not be based on the sensitivity of an analytical method. When aquatic organisms are more sensitive than routine analytical methods, the proper solution is to develop better analytical methods, not to underprotect aquatic life.

## II. Collection of Data

A. Collect all available data on the material concerning (a) toxicity to, and bioaccumulation by, aquatic animals and plants, (b) FDA action levels [12], and (c) chronic feeding studies and long-term field studies with wildlife species that regularly consume aquatic organisms.

B. All data that are used should be available in typed, dated, and signed hard copy (publication, manuscript, letter, memorandum, etc.) with enough supporting information to indicate that acceptable test procedures were used and that the results are probably reliable. In some cases it may be appropriate to obtain additional written information from the investigator, if possible. Information that is confidential or privileged or otherwise not available for distribution should not be used.

C. Questionable data, whether published or unpublished, should not be used. For example, data should usually be rejected if they are from tests that did not contain a control treatment, tests in which too many organisms in the control treatment died or showed signs of stress or disease, and tests in which distilled or deionized water was used as the dilution water without addition of appropriate salts.

D. Data on technical grade materials may be used if appropriate, but data on formulated mixtures and emulsifiable concentrates of the material of concern should not be used.

E. For some highly volatile, hydrolyzable, or degradable materials it is probably appropriate to use only results of flow-through tests in which the concentrations of test material in the test solutions were measured often enough using acceptable analytical methods.

F. Data should be rejected if they were obtained using:

1. Brine shrimp, because they usually only occur naturally in water with salinity greater than 35 g/kg.

2. Species that do not have reproducing wild populations in North America (see Appendix 1).

3. Organisms that were previously exposed to substantial concentrations of the test material or other contaminants.

G. Questionable data, data on formulated mixtures and emulsifiable concentrates, and data obtained with non-resident species in North America or previously exposed organisms may be used to provide auxiliary information but should not be used in the derivation of criteria.

## III. Required data

A. Certain data should be available to help ensure that each of the four major kinds of possible adverse effects receives adequate consideration. Results of acute and chronic toxicity tests with representative species of aquatic animals are necessary so that data available for tested species can be considered a useful indication of the sensitivities of

appropriate untested species. Fewer data concerning toxicity to aquatic plants are required because procedures for conducting tests with plants and interpreting the results of such tests are not as well developed. Data concerning bioaccumulation by aquatic organisms are only required if relevant data are available concerning the significance of residues in aquatic organisms.

B. To derive a criterion for freshwater aquatic organisms and their uses, the following should be available:

1. Results of acceptable acute tests (see Section IV) with at least one species of freshwater animal in at least eight different families such that all of the following are included:

    a. the family Salmonidae in the class Osteichthyes

    b. a second family in the class Osteichthyes, preferably a commercially or recreationally important warmwater species (e.g., bluegill, channel catfish, etc.)

    c. a third family in the phylum Chordata (may be in the class Osteichthyes or may be an amphibian, etc.)

    d. a planktonic crustacean (e.g., cladoceran, copepod, etc.)

    e. a benthic crustacean (e.g., ostracod, isopod, amphipod, crayfish, etc.)

    f. an insect (e.g., mayfly, dragonfly, damselfly, stonefly, caddisfly, mosquito, midge, etc.)

    g. a family in a phylum other than Arthropoda or Chordata (e.g., Rotifera, Annelida, Mollusca, etc.)

    h. a family in any order of insect or any phylum not already represented.

2. Acute-chronic ratios (see Section VI) with species of aquatic animals in at least three different families provided that one of the three species:

    - at least one is a fish
    - at least one is an invertebrate
    - at least one is an acutely sensitive freshwater species (the other two may be saltwater species).

3. Results of at least one acceptable test with a freshwater alga or vascular plant (see Section VIII). If plants are among the aquatic organisms that are most sensitive to the material, results of a test with a plant in another phylum (division) should also be available.

4. At least one acceptable bioconcentration factor determined with an appropriate freshwater species, if a maximum permissible tissue concentration is available (see Section IX).

C. To derive a criterion for saltwater aquatic organisms and their uses, the following should be available:

1. Results of acceptable acute tests (see Section IV) with at least one species of saltwater animal in at least eight different families such that all of the following are included:

   a. two families in the phylum Chordata

   b. a family in a phylum other than Arthropoda or Chordata

   c. either the Mysidae or Penaeidae family

   d. three other families not in the phylum Chordata (may include Mysidae or Penaeidae, whichever was not used above)

   e. any other family.

2. Acute-chronic ratios (see Section VI) with species of aquatic animals in at least three different families provided that of the three species:

   - at least one is a fish
   - at least one is an invertebrate
   - at least one is an acutely sensitive saltwater species (the other two may be freshwater species).

3. Results of at least one acceptable test with a saltwater alga or vascular plant (see Section VIII). If plants are among the aquatic organisms most sensitive to the material, results of a test with a plant in another phylum (division) should also be available.

4. At least one acceptable bioconcentration factor determined with an appropriate saltwater species, if a maximum permissible tissue concentration is available (see Section IX).

D. If all the required data are available, a numerical criterion can usually be derived, except in special cases. For example, derivation of a criterion might not be possible if the available acute-chronic ratios vary by more than a factor of ten with no apparent pattern. Also, if a criterion is to be related to a water quality characteristic (see Sections V and VII), more data will be necessary.

Similarly, if all required data are not available, a numerical criterion should not be derived except in special cases. For example, even if not enough acute and chronic data are available, it might be possible to derive a criterion if the available data

clearly indicate that the Final Residue Value should be much lower than either the Final Chronic Value or Final Plant Value.

E. Confidence in a criterion usually increases as the amount of available pertinent data increases. Thus, additional data are usually desirable.

## IV. Final Acute Value

A. Appropriate measures of the acute (short-term) toxicity of the material to a variety of species of aquatic animals are used to calculate the Final Acute Value. The Final Acute Value is an estimate of the concentration of the material corresponding to a cumulative probability of 0.05 in the acute toxicity values for the genera with which acceptable acute tests have been conducted on the material. However, in some cases, if the Species Mean Acute Value of a commercially or recreationally important species is lower than the calculated Final Acute Value, then that Species Mean Acute Value replaces the calculated Final Acute Value in order to provide protection for that important species.

B. Acute toxicity tests should have been conducted using acceptable procedures [13].

C. Except for test with saltwater annelids and mysids, results of acute tests during which the test organisms were fed should not be used, unless data indicate that the food did not affect the toxicity of the test material.

D. Results of acute tests conducted in unusual dilution water, e.g., dilution water in which total organic carbon or particulate matter exceeded 5 mg/L, should not be used, unless a relationship is developed between acute toxicity and organic carbon or particulate matter or unless data show that organic carbon, particulate matter, etc., do not affect toxicity.

E. Acute values should be based on endpoints which reflect the total severe acute adverse impact of the test material on the organisms used in the test. Therefore, only the following kinds of data on acute toxicity to aquatic animals should be used:

1. Tests with daphnids and other cladocerans should be started with organisms less than 24 hours old and tests with midges should be started with second- or third-instar larvae. The result should be the 48-hr EC50 based on percentage of organisms immobilized plus percentage of organisms killed. If such an EC50 is not available from a test, the 48-hr LC50 should be used in place of the desired 48-hr EC50. An EC50 or LC50 of longer than 48 hr can be used as long as the animals were not fed and the control animals were acceptable at the end of the test.

2. The result of a test with embryos and larvae of barnacles, bivalve molluscs (clams, mussels, oysters, and scallops), sea urchins, lobsters, crabs, shrimp, and abalones, should be the 96-hr EC50 based on the percentage of organisms with incompletely developed shells plus the percentage of organisms killed. If such an EC50 is not available from a test, the lower of the 96-hr EC50 based on the percentage of organisms with incompletely developed shells and the 96-hr LC50

should be used in place of the desired 96-hr EC50. If the duration of the test was between 48 and 96 hr, the EC50 or LC50 at the end of the test should be used.

3. The acute values from tests with all other freshwater and saltwater animal species and older life stages of barnacles, bivalve molluscs, sea urchins, lobsters, crabs, shrimps, and abalones should be the 96-hr EC50 based on the percentage of organisms exhibiting loss of equilibrium plus the percentage of organisms immobilized plus the percentage of organisms killed. If such an EC50 is not available from a test, the 96-hr LC50 should be used in place of the desired 96-hr EC50.

4. Tests with single-celled organisms are not considered acute tests, even if the duration was 96 hours or less.

5. If the tests were conducted properly, acute values reported as "greater than" values and those which are above the solubility of the test material should be used, because rejection of such acute values would unnecessarily lower the Final Acute Value by eliminating acute values for resistant species.

F. If the acute toxicity of the material to aquatic animals apparently has been shown to be related to a water quality characteristic such as hardness or particulate matter for freshwater animals or salinity or particulate matter for saltwater animals, a Final Acute Equation should be derived based on that water quality characteristic. Go to Section V.

G. If the available data indicate that one or more life stages are at least a factor of two more resistant than one or more other life stages of the same species, the data for the more resistant life stages should not be used in the calculation of the Species Mean Acute Value because a species can only be considered protected from acute toxicity if all life stages are protected.

H. The agreement of the data within and between species should be considered. Acute values that appear to be questionable in comparison with other acute and chronic data for the same species and for other species in the same genus probably should not be used in calculation of a Species Mean Acute Value. For example, if the acute values available for a species or genus differ by more than a factor of 10, some or all of the values probably should not be used in calculations.

I. For each species for which at least one acute value is available, the Species Mean Acute Value (SMAV) should be calculated as the geometric mean of the results of all flow-through tests in which the concentrations of test material were measured. For a species for which no such result is available, the SMAV should be calculated as the geometric mean of all available acute values, i.e., results of flow-through tests in which the concentrations were not measured and results of static and renewal tests based on initial concentrations (nominal concentrations are acceptable for most test materials if measured concentrations are not available) of test material.

**NOTE:** Data reported by original investigators should not be rounded off. Results of all intermediate calculations should be rounded [14] to four significant digits.

**NOTE:** The geometric mean of N numbers is the Nth root of the product of the N numbers. Alternatively, the geometric mean can be calculated by adding the logarithms of the N numbers, dividing the sum by N, and taking the antilog of the quotient. The geometric mean of two numbers is the square root of the product of the two numbers, and the geometric mean of one number is that number. Either natural (base e) or common (base 10) logarithms can be used to calculate geometric means as long as they are used consistently within each set of data, i.e., the antilog used must match the logarithm used.

**NOTE:** Geometric means, rather than arithmetic means, are used here because the distributions of sensitivities of individual organisms in toxicity tests on most materials and the distributions of sensitivities of species within a genus are more likely to be lognormal than normal. Similarly, geometric means are used for acute-chronic ratios and bioconcentration factors because quotients are likely to be closer to lognormal than normal distributions. In addition, division of the geometric mean of a set of numerators by the geometric mean of the set of corresponding denominators will result in the geometric mean of the set of corresponding quotients.

J. For each genus for which one or more SMAVs are available, the Genus Mean Acute Value (GMAV) should be calculated as the geometric mean of the SMAVs available for the genus.

K. Order the GMAVs from high to low.

L. Assign ranks, R, to the GMAVs from "1" for the lowest to "N" for the highest. If two or more GMAVs are identical, arbitrarily assign them successive ranks.

M. Calculate the cumulative probability, P, for each GMAV as R/(N+1).

N. Select the four GMAVs which have cumulative probabilities closest to 0.05 (if there are less than 59 GMAVs, these will always be the four lowest GMAVs).

O. Using the selected GMAVs and Ps, calculate

$$S^2 = \frac{\sum((\ln GMAV)^2) - ((\sum \ln GMAV))^2 / 4}{\sum \ (F) - ((\sum(\sqrt{P}))^2 / 4)}$$

$$L = (\sum \ (\ln GMAV) - S(\sum(\sqrt{P}))) / 4$$

$$A = S(\sqrt{0.05}) + L$$

$$FAV = e^A$$

(See [11] for development of the calculation procedure and Appendix 2 for an example calculation~~s~~ and computer program.)

**NOTE:** Natural logarithms (logarithms to base e, denoted as ln) are used herein merely because they are easier to use on some hand calculators and computers than common (base 10) logarithms. Consistent use of either will produce the same result.

P. If for a commercially or recreationally important species the geometric mean of the acute values from ~~the~~ flow-through tests in which the concentrations of test material were measured is lower than the calculated Final Acute Value, then that geometric mean should be used as the Final Acute Value instead of the calculated Final Acute Value.

Q. Go to Section VI.

## V. Final Acute Equation

A. When enough data are available to show that acute toxicity to two or more species is similarly related to a water quality characteristic, the relationship should be taken into account as described in Sections B-G below or using analysis of covariance [15, 16]. The two methods are equivalent and produce identical results. The manual method described below provides an understanding of this application of covariance analysis, but computerized versions of covariance analysis are much more convenient for analyzing large data sets. If two or more factors affect toxicity, multiple regression analysis should be used.

B. For each species for which comparable acute toxicity values are available at two or more different values of the water quality characteristic, perform a least squares regression of the acute toxicity values on the corresponding values of the water quality characteristic to obtain the slope and its 95% confidence limits for each species.

**NOTE:** Because the best documented relationship is that between hardness and acute toxicity of metals in fresh water and a log-log relationship fits these data, geometric means and natural logarithms of both toxicity and water quality are used in the rest of this section. For relationships based on other water quality characteristics, such as pH, temperature, or salinity, no transformation or a different transformation might fit the data better, and appropriate changes will be necessary throughout this section.

C. Decide whether the data for each species is useful, taking into account the range and number of the tested values of the water quality characteristic and the degree of agreement within and between species. For example, a slope based on six data points might be of limited value if it is based only on data for a very narrow range of values of the water quality characteristic. A slope based on only two data points, however, might be useful if it is consistent with other information and if the two points cover a broad enough range of the water quality characteristic. In addition, acute values that appear to be questionable in comparison with other acute and chronic data available for the same species and for other species in the same genus probably should not be used. For example, if after adjustment for the water quality characteristic, the acute values available for a species or genus differ by more than a factor of 10, rejection of some or all of the values is probably appropriate. If useful slopes are not available for at least one fish and one invertebrate or if the available slopes are too dissimilar or if too few data are available to adequately define the relationship between acute toxicity and the water quality characteristic, return to Section IV.G., using the results of tests

conducted under conditions and in waters similar to those commonly used for toxicity tests with the species.

D. Individually for each species calculate the geometric mean of the available acute values and then divide each of the acute values for a species by the mean for the species. This normalizes the acute values so that the geometric mean of the normalized values for each species individually and for any combination of species is 1.0.

E. Similarly normalize the values of the water quality characteristic for each species individually.

F. Individually for each species perform a least squares regression of the normalized acute toxicity values on the corresponding normalized values of the water quality characteristic. The resulting slopes and 95% confidence limits will be identical to those obtained in Section B above. Now, however, if the data are actually plotted, the line of best fit for each individual species will go through the point 1,1 in the center of the graph.

G. Treat all the normalized data as if they were all for the same species and perform a least squares regression of all the normalized acute values on the corresponding normalized values of the water quality characteristic to obtain the pooled acute slope, V, and its 95% confidence limits. If all the normalized data are actually plotted, the line of best fit will go through the point 1,1 in the center of the graph.

H. For each species calculate the geometric mean, W, of the acute toxicity values and the geometric mean, X, of the values of the water quality characteristic. (These were calculated in steps D and E above.)

I. For each species calculate the logarithm, Y, of the SMAV at a selected value, Z, of the water quality characteristic using the equation:

$Y = \ln W - V(\ln X - \ln Z)$.

J. For each species calculate the SMAV at Z using the equation: $SMAV = e^{Y}$.

**NOTE:** Alternatively, the SMAVs at Z can be obtained by skipping step H above, using the equations in steps I and J to adjust each acute value individually to Z, and then calculating the geometric mean of the adjusted values for each species individually. This alternative procedure allows an examination of the range of the adjusted acute values for each species.

K. Obtain the Final Acute Value at Z by using the procedure described in Section IV.J-O.

L. If the SMAV at Z of a commercially or recreationally important species is lower than the calculated Final Acute Value at Z, then that SMAV should be used as the Final Acute Value at Z instead of the calculated Final Acute Value.

M. The Final Acute Equation is written as: Final Acute Value = $e^{(V[\ln(\text{water quality characteristic})] + \ln A - V[\ln Z])}$, where V = pooled acute slope and A = Final Acute Value at Z. Because

V, A, and Z are known, the Final Acute Value can be calculated for any selected value of the water quality characteristic.

## VI. Final Chronic Value

A. Depending on the data that are available concerning chronic toxicity to aquatic animals, the Final Chronic Value might be calculated in the same manner as the Final Acute Value or by dividing the Final Acute Value by the Final Acute-Chronic Ratio. In some cases it may not be possible to calculate a Final Chronic Value.

**NOTE:** As the name implies, the acute-chronic ration (ARC) is a way of relating acute and chronic toxicities. The acute-chronic ratio is basically the inverse of the application factor, but this new name is better because it is more descriptive and should help prevent confusion between "application factors" and "safety factors". Acute-chronic ratios and application factors are ways of relating the acute and chronic toxicities of a material to aquatic organisms. Safety factors are used to provide an extra margin of safety beyond the known or estimated sensitivities of aquatic organisms. Another advantage of the acute-chronic ratio is that it will usually be greater than one; this should avoid the confusion as to whether a large application factor is one that is close to unity or one that has a denominator that is much greater than the numerator.

B. Chronic values should be based on results of flow-through (except renewal is acceptable for daphnids) chronic tests in which the concentrations of test material in the test solutions were properly measured at appropriate times during the test.

C. Results of chronic tests in which survival, growth, or reproduction in the control treatment was unacceptably low should not be used. The limits of acceptability will depend on the species.

D. Results of chronic tests conducted in unusual dilution water, e.g., dilution water in which total organic carbon or particulate matter exceeded 5 mg/L, should not be used, unless a relationship is developed between chronic toxicity and organic carbon or particulate matter or unless data show that organic carbon, particulate matter, etc., do not affect toxicity.

E. Chronic values should be based on endpoints and lengths of exposure appropriate to the species. Therefore, only results of the following kinds of chronic toxicity tests should be used:

1. Life-cycle toxicity tests consisting of exposures of each of two or more groups of individuals of a species to a different concentration of the test material throughout a life cycle. To ensure that all life stages and life processes are exposed, tests with fish should begin with embryos or newly hatched young less than 48 hours old, continue through maturation and reproduction, and should end not less than 24 days (90 days for salmonids) after the hatching of the next generation. Tests with daphnids should begin with young less than 24 hours old and last for not less than 21 days. Tests with mysids should begin with young less than 24 hours old and continue until 7 days past the median time of first brood release in the

controls. For fish, data should be obtained and analyzed on survival and growth of adults and young, maturation of males and females, eggs spawned per female, embryo viability (salmonids only), and hatchability. For daphnids, data should be obtained and analyzed on survival and young per female. For mysids, data should be obtained and analyzed on survival, growth, and young per female.

2. Partial life-cycle toxicity tests consisting of exposures of each of two or more groups of individuals of a species of fish to a different concentration of the test material through most portions of a life cycle. Partial life-cycle tests are allowed with fish species that require more than a year to reach sexual maturity, so that all major life stages can be exposed to the test material in less than 15 months. Exposure to the test material should begin with immature juveniles at least 2 months prior to active gonad development, continue through maturation and reproduction, and end not less than 24 days (90 days for salmonids) after the hatching of the next generation. Data should be obtained and analyzed on survival and growth of adults and young, maturation of males and females, eggs spawned per female, embryo viability (salmonids only), and hatchability.

3. Early life-stage toxicity tests consisting of 28- to 32-day (60 days post hatch for salmonids) exposures of the early life stages of a species of fish from shortly after fertilization through embryonic, larval, and early juvenile development. Data should be obtained and analyzed on survival and growth.

   **NOTE:** Results of an early life-stage test are used as predictions of results of life-cycle and partial life-cycle tests with the same species. Therefore, when results of a life-cycle or partial life-cycle test are available, results of an early life-stage test with the same species should not be used. Also, results of early life-stage tests in which the incidence of mortalities or abnormalities increased substantially near the end of the test should not be used because results of such tests are possibly not good predictions of the results of comparable life-cycle or partial life-cycle tests.

F. A chronic value may be obtained by calculating the geometric mean of the lower and upper chronic limits from a chronic test or by analyzing chronic data using regression analysis. A lower chronic limit is the highest tested concentration (a) in an acceptable chronic test, (b) which did not cause an unacceptable amount of adverse effect on any of the specified biological measurements, and (c) below which no tested concentration caused an unacceptable effect. An upper chronic limit is the lowest tested concentration (a) in an acceptable chronic test, (b) which did cause an unacceptable amount of adverse effect on one or more of the specified biological measurements, and (c) above which all tested concentrations also caused such an effect.

**NOTE:** Because various authors have used a variety of terms and definitions to interpret and report results of chronic tests, reported results should be reviewed carefully. The amount of effect that is considered unacceptable is often based on a statistical hypothesis test, but might also be defined in terms of a specified percent reduction from the controls. A small percent reduction (e.g., 3%) might be

considered acceptable even if it is statistically significantly different from the control, whereas a large percent reduction (e.g., 30%) might be considered unacceptable even if it is not statistically significant.

G. If the chronic toxicity of the material to aquatic animals apparently has been shown to be related to a water quality characteristic such as hardness or particulate matter for freshwater animals or salinity or particulate matter for saltwater animals, a Final Chronic Equation should be derived based on that water quality characteristic. Go to Section VII.

H. If chronic values are available for species in eight families as described in Sections III.B.1 or III.C.1, a Species Mean Chronic Value (SMCV) should be calculated for each species for which at least one chronic value is available by calculating the geometric mean of all chronic values available for the species, and appropriate Genus Mean Chronic Values should be calculated. The Final Chronic Value should then be obtained using the procedure described in Section IV.J-O. Then go to Section VI.M.

I. For each chronic value for which at least one corresponding appropriate acute value is available, calculate an acute-chronic ratio, using for the numerator the geometric mean of the results of all acceptable flow-through (except static is acceptable for daphnids) acute tests in the same dilution water and in which the concentrations were measured. For fish, the acute test(s) should have been conducted with juveniles. The acute test(s) should have been part of the same study as the chronic test. If acute tests were not conducted as part of the same study, acute tests conducted in the same laboratory and dilution water, but in a different study, may be used. If no such acute tests are available, results of acute tests conducted in the same dilution water in a different laboratory may be used. If no such acute tests are available, an acute-chronic ratio should not be calculated.

J. For each species, calculate the species mean acute-chronic ratio as the geometric mean of all acute-chronic ratios available for that species.

K. For some materials the acute-chronic ratio seems to be the same for all species, but for other materials the ratio seems to increase or decrease as the Species Mean Acute Value (SMAV) increases. Thus the Final Acute-Chronic Ratio can be obtained in four ways, depending on the data available:

1. If the species mean acute-chronic ratio~~s~~ seems to increase or decrease as the SMAV increases, the Final Acute-Chronic Ratio should be calculated as the geometric mean of the acute-chronic ratios for species whose SMAVs are close to the Final Acute Value.

2. If no major trend is apparent and the acute-chronic ratios for a number of species are within a factor of ten, the Final Acute-Chronic Ratio should be calculated as the geometric mean of all the species mean acute-chronic ratios available for both freshwater and saltwater species.

3. For acute tests conducted on metals and possibly other substances with embryos and larvae of barnacles, bivalve molluscs, sea urchins, lobsters,

crabs, shrimp, and abalones (see Section IV.E.2), it is probably appropriate to assume that the acute-chronic ratio is 2. Chronic tests are very difficult to conduct with most such species, but it is likely that the sensitivities of embryos and larvae would determine the results of life-cycle tests. Thus, if the lowest available SMAVs were determined with embryos and larvae of such species, the Final Acute-Chronic Ratio should probably be assumed to be 2, so that the Final Chronic Value is equal to the Criterion Maximum Concentration (see Section XI.B).

4. If the most appropriate species mean acute-chronic ratios are less than 2.0, and especially if they are less than 1.0, acclimation has probably occurred during the chronic test. Because continuous exposure and acclimation cannot be assured to provide adequate protection in field situations, the Final Acute-Chronic Ratio should be assumed to be 2, so that the Final Chronic Value is equal to the Criterion Maximum Concentration (see Section XI.B).

If the available species mean acute-chronic ratios do not fit one of these cases, a Final Acute-Chronic Ratio probably cannot be obtained, and a Final Chronic Value probably cannot be calculated.

L. Calculate the Final Chronic Value by dividing the Final Acute Value by the Final Acute-Chronic Ratio. If there was a Final Acute Equation rather than a Final Acute Value, see also Section VII.A.

M. If the Species Mean Chronic Value of a commercially or recreationally important species is lower than the calculated Final Chronic Value, then that Species Mean Chronic Value should be used as the Final Chronic Value instead of the calculated Final Chronic Value.

N. Go to Section VIII.

## VII. Final Chronic Equation

A. A Final Chronic Equation can be derived in two ways. The procedure described here in Section A will result in the chronic slope being the same as the acute slope. The procedure described in Sections B-N will usually result in the chronic slope being different from the actual slope.

1. If acute-chronic ratios are available for enough species at enough values of the water quality characteristic to indicate that the acute-chronic ratio is probably the same for all species and is probably independent of the water quality characteristic, calculate the Final Acute-Chronic Ratio as the geometric mean of the available species mean acute-chronic ratios.

2. Calculate the Final Chronic Value at the selected value Z of the water quality characteristic by dividing the Final Acute Value at Z (see Section V.M.) by the Final Acute-Chronic Ratio.

3. Use V = pooled acute slope (see section V.M.) as L = pooled chronic slope.

4. Go to Section VII.M.

B. When enough data are available to show that chronic toxicity to at least one species is related to a water quality characteristic, the relationship should be taken into account as described in Sections B-G below or using analysis of covariance [15, 16]. The two methods are equivalent and produce identical results. The manual method described below provides an understanding of this application of covariance analysis, but computerized versions of covariance analysis are much more convenient for analyzing large data sets. If two more factors affect toxicity, multiple regression analysis should be used.

C. For each species for which comparable chronic toxicity values are available at two or more different values of the water quality characteristic, perform a least squares regression of the chronic toxicity values on the corresponding values of the water quality characteristic to obtain the slope and its 95% confidence limits for each species.

**NOTE:** Because the best documented relationship is that between hardness and acute toxicity of metals in fresh water and a log-log relationship fits these data, geometric means and natural logarithms of both toxicity and water quality are used in the rest of this section. For relationships based on other water quality characteristics, such as pH, temperature, or salinity, no transformation or a different transformation might fit the data better, and appropriate changes will be necessary throughout this section. It is probably preferable, but not necessary, to use the same transformation that was used with the acute values in Section V.

D. Decide whether the data for each species is useful, taking into account the range and number of the tested values of the water quality characteristic and the degree of agreement within and between species. For example, a slope based on six data points might be of limited value if it is based only on data for a very narrow range of values of the water quality characteristic. A slope based on only two data points, however, might be useful if it is consistent with other information and if the two points cover a broad enough range of the water quality characteristic. In addition, chronic values that appear to be questionable in comparison with other acute and chronic data available for the same species and for other species in the same genus probably should not be used. For example, if after adjustment for the water quality characteristic, the chronic values available for a species or genus differ by more than a factor of 10, rejection of some or all of the values is probably appropriate. If a useful chronic slope is not available for at least one species or if the available slopes are too dissimilar or if too few data are available to adequately define the relationship between chronic toxicity and the water quality characteristic, it might be appropriate to assume that the chronic slope is the same as the acute slope, which is equivalent to assuming that the acute-chronic ratio is independent of the water quality characteristic. Alternatively, return to Section VI.H, using the results of tests

conducted under conditions and in waters similar to those commonly used for toxicity tests with the species.

E. Individually for each species calculate the geometric mean of the available chronic values and then divide each chronic value for a species by the mean for the species. This normalizes the chronic values so that the geometric mean of the normalized values for each species individually and for any combination of species is 1.0.

F. Similarly normalize the values of the water quality characteristic for each species individually.

G. Individually for each species perform a least squares regression of the normalized chronic toxicity values on the corresponding normalized values of the water quality characteristic. The resulting slopes and the 95% confidence limits will be identical to those obtained in Section B above. Now, however, if the data are actually plotted, the line of best fit for each individual species will go through the point 1,1 in the center of the graph.

H. Treat all the normalized data as if they were all for the same species and perform a least squares regression of all the normalized chronic values on the corresponding normalized values of the water quality characteristic to obtain the pooled chronic slope, L, and its 95% confidence limits. If all the normalized data are actually plotted, the line of best fit will go through the point 1,1 in the center of the graph.

I. For each species calculate the geometric mean, M, of the toxicity values and the geometric mean, P, of the values of the water quality characteristic. (These were calculated in steps E and F above.)

J. For each species calculated the logarithm, Q, of the Species Mean Chronic Value at a selected value, Z, of the water quality characteristic using the equation: $Q = \ln M - L(\ln P - \ln Z)$.

**NOTE:** Although it is not necessary, it will usually be best to use the same value of the water quality characteristic here as was used in Section V.I.

K. For each species calculate a Species Mean Chronic Value at Z using the equation: $SMCV = e^{Q}$.

**NOTE:** Alternatively, the Species Mean Chronic Values at Z can be obtained by skipping step J above, using the equations in steps J and K to adjust each acute value individually to Z and then calculating the geometric means of the adjusted values for each species individually. This alternative procedure allows an examination of the range of the adjusted chronic values for each species.

L. Obtain the Final Chronic Value at Z by using the procedure described in Section IV.J-O.

M. If the Species Mean Chronic Value at Z of a commercially or recreationally important species is lower than the calculated Final Chronic Value at Z, then that Species Mean

N. The Final Chronic Equation is written as: Final Chronic Value = $e^{(L[\ln(\text{water quality characteristic})] + \ln S - L[\ln Z])}$, where L = pooled chronic slope and S = Final Chronic Value at Z. Because L, S and Z are known, the Final Chronic Value can be calculated for any selected value of the water quality characteristic.

## VIII. Final Plant Value

A. Appropriate measures of the toxicity of the material to aquatic plants are used to compare the relative sensitivities of aquatic plants and animals. Although procedures for conducting and interpreting the results of toxicity tests with plants are not well developed, results of tests with plants usually indicate that criteria which adequately protect aquatic animals and their uses will probably also protect aquatic plants and their uses.

B. A plant value is the result of a 96-hr test conducted with an alga or a chronic test conducted with an aquatic vascular plant.

**NOTE:** A test of the toxicity of a metal to a plant usually should not be used if the medium contained an excessive amount of a complexing agent, such as EDTA, that might affect the toxicity of the metal. Concentrations of EDTA above about 200 µg/L should probably be considered excessive.

C. The Final Plant Value should be obtained by selecting the lowest result from a test with an important aquatic plant species in which the concentrations of test material were measured and the endpoint was biologically important.

## IX. Final Residue Value

A. The Final Residue Value is intended to (a) prevent concentrations in commercially or recreationally important aquatic species from affecting marketability because of exceedance of applicable FDA action levels and (b) protect wildlife, including fishes and birds, that consume aquatic organisms from demonstrated unacceptable effects. The Final Residue Value is the lowest of the residue values that are obtained by dividing maximum permissible tissue concentrations by appropriate bioconcentration or bioaccumulation factors. A maximum permissible tissue concentration is either (a) an FDA action level [12] for fish oil or for the edible portion of fish or shellfish, or (b) a maximum acceptable dietary intake based on observations on survival, growth, or reproduction in a chronic wildlife feeding study or a long-term wildlife field study. If no maximum permissible tissue concentration is available, go to Section X because no Final Residue Value can be derived.

B. Bioconcentration factors (BCFs) and bioaccumulation factors (BAFs) are quotients of the concentration of a material in one or more tissues of an aquatic organism divided by the average concentration in the solution in which the organism had been living. A BCF is intended to account only for net uptake directly from water, and thus almost

has to be measured in a laboratory test. Some uptake during the bioconcentration test might not be directly from water if the food sorbs some of the test material before it is eaten by the test organisms. A BAF is intended to account for the net uptake from both food and water in a real-world situation. A BAF almost has to be measured in a field situation in which predators accumulate the material directly from water and by consuming prey that itself could have accumulated the material from both food and water. The BCF and BAF are probably similar for a material with a low BCF, but the BAF is probably higher than the BCF for materials with high BCFs. Although BCFs are not too difficult to determine, very few BAFs have been measured acceptably because it is necessary to make enough measurements of the concentration of the material in water to show that it was reasonably constant for a long enough period of time over the range of territory inhabited by the organisms. Because so few acceptable BAFs are available, only BCFs will be discussed further. However, if an acceptable BAF is available for a material, it should be used instead of any available BCFs.

C. If a maximum permissible tissue concentration is available for a substance (e.g., parent material, parent material plus metabolites, etc.), the tissue concentration used in the calculation of the BCF should be for the same substance. Otherwise~~,~~ the tissue concentration used in the calculation of the BCF should be that of the material and its metabolites which are structurally similar and are not much more soluble in water than the parent material.

D.

1. A BCF should be used only if the test was flow-through, the BCF was calculated based on measured concentrations of the test material in tissue and in the test solution, and the exposure continued at least until either apparent steady-state or 28 days was reached. Steady-state is reached when the BCF does not change significantly over a period of time, such as two days or 16 percent of the length of the exposure, whichever is longer. The BCF used from a test should be the highest of (a) the apparent steady-state BCF, if apparent steady-state was reached, (b) the highest BCF obtained, if apparent steady-state was not reached, and (c) the projected steady-state BCF, if calculated.

2. Whenever a BCF is determined for a lipophilic material, the percent lipids should also be determined in the tissue(s) for which the BCF was calculated.

3. A BCF obtained from an exposure that adversely affected the test organisms may be used only if it is similar to a BCF obtained with unaffected organisms of the same species at lower concentrations that did not cause adverse effects.

4. Because maximum permissible tissue concentrations are almost never based on dry weights, a BCF calculated using dry tissue weights must be converted to a wet tissue weight basis. If no conversion factor is reported with the BCF, multiply the dry weight BCF by 0.1 for plankton and by 0.2 for individual species of fishes and invertebrates [17].

5. If more than one acceptable BCF is available for a species, the geometric mean of the available values should be used, except that if the BCFs are from different lengths of exposure and the BCF increases with length of exposure, the BCF for the longest exposure should be used.

E. If enough pertinent data exist, several residue values can be calculated by dividing maximum permissible tissue concentrations by appropriate BCFs:

1. For each available maximum acceptable dietary intake derived from a chronic feeding study or a long-term field study with wildlife, including birds and aquatic organisms, the appropriate BCF is based on the whole body of aquatic species which constitute or represent a major portion of the diet of the tested wildlife species.

2. For an FDA action level for fish or shellfish, the appropriate BCF is the highest geometric mean species BCF for the edible portion (muscle for decapods, muscle with or without skin for fishes, adductor muscle for scallops, and total soft tissue for other bivalve molluscs) of a consumed species. The highest species BCF is used because FDA action levels are applied on a species-by-species basis.

F. For lipophilic materials, it might be possible to calculate additional residue values. Because the steady-state BCF for a lipophilic material seems to be proportional to percent lipids from one tissue to another and from one species to another [18, 19, 20], extrapolations can be made from tested tissues or species to untested tissues or species on the basis of percent lipids.

1. For each BCF for which the percent lipids is known for the same tissue for which the BCF was measured, normalize the BCF to a one percent lipid basis by dividing the BCF by the percent lipids. This adjustment to a one percent lipid basis is intended to make all the measured BCFs for a material comparable regardless of the species or tissue with which the BCF was measured.

2. Calculate the geometric mean normalized BCF. Data for both saltwater and freshwater species should be used to determine the mean normalized BCF, unless the data show that the normalized BCFs are probably not similar.

3. Calculate all possible residue values by dividing the available maximum permissible tissue concentrations by the mean normalized BCF and by the percent lipids values appropriate to the maximum permissible tissue concentrations, i.e.,

$$\text{Residue Value} = \frac{(\text{maximum permissible tissue concentration})}{(\text{mean normalized BCF})\,(\text{appropriate percent lipids})}$$

a. For an FDA action level for fish oil, the appropriate percent lipids value is 100.

b. For an FDA action level for fish, the appropriate percent lipids value is 11 for freshwater criteria and 10 for saltwater criteria because FDA action levels are applied on a species-by-species basis to commonly consumed species. The highest lipid contents in the edible portions of important consumed species are about 11 percent for both the freshwater chinook salmon and lake trout and about 10 percent for the saltwater Atlantic herring [21].

c. For a maximum acceptable dietary intake derived from a chronic feeding study or a long-term field study with wildlife, the appropriate percent lipids is that of an aquatic species or group of aquatic species which constitute a major portion of the diet of the wildlife species.

G. The Final Residue Value is obtained by selecting the lowest of the available residue values.

**NOTE:** In some cases the Final Residue Value will not be low enough. For example, a residue value calculated from an FDA action level will probably result in an average concentration in the edible portion of a fatty species that is at the action level. Some individual organisms, and possibly some species, will have residue concentrations higher than the mean value but no mechanism has been devised to provide appropriate additional protection. Also, some chronic feeding studies and long-term field studies with wildlife identify concentrations that cause adverse effects but do not identify concentrations which do not cause adverse effects; again no mechanism has been devised to provide appropriate additional protection. These are some of the species and uses that are not protected at all times in all places.

## X. Other Data

Pertinent information that could not be used in earlier sections might be available concerning adverse effects on aquatic organisms and their uses. The most important of these are data on cumulative and delayed toxicity, flavor impairment, reduction in survival, growth, or reproduction, or any other adverse effect that has been shown to be biologically important. Especially important are data for species for which no other data are available. Data from behavioral, biochemical, physiological, microcosm, and field studies might also be available. Data might be available from tests conducted in unusual dilution water (see IV.D and VI.D), from chronic tests in which the concentrations were not measured (see VI.B), from tests with previously exposed organisms (see II.F), and from tests on formulated mixtures or emulsifiable concentrates (see II.D). Such data might affect a criterion if the data were obtained with an important species, the test concentrations were measured, and the endpoint was biologically important.

## XI. Criterion

A. A criterion consists of two concentrations: the Criterion Maximum Concentration and the Criterion Continuous Concentration.

B. The Criterion Maximum Concentration (CMC) is equal to one-half the Final Acute Value.

C. The Criterion Continuous Concentration (CCC) is equal to the lowest of the Final Chronic Value, the Final Plant Value, and the Final Residue Value, unless other data (see Section X) show that a lower value should be used. If toxicity is related to a water quality characteristic, the CCC is obtained from the Final Chronic Equation, the Final Plant Value, and the Final Residue Value by selecting the one, or the combination, that results in the lowest concentrations in the usual range of the water quality characteristic, unless other data (see Section X) show that a lower value should be used.

D. Round [14] both the CMC and the CCC to two significant digits.

E. The criterion is stated as:

The procedures described in the "Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses" indicate that, except possibly where a locally important species is very sensitive, (1) aquatic organisms and their uses should not be affected unacceptably if the four-day average concentration of (2) does not exceed (3) µg/L more than once every three years on the average and if the one-hour average concentration does not exceed (4) µg/L more than once every three years on the average.

where (1) = insert "freshwater" or "saltwater"

(2) = insert name of material

(3) = insert the Criterion Continuous Concentration

(4) = insert the Criterion Maximum Concentration.

## XII. Final Review

A. The derivation of the criterion should be carefully reviewed by rechecking each step of the Guidelines. Items that should be especially checked are:

1. If unpublished data are used, are they well documented?
2. Are all required data available?
3. Is the range of acute values for any species greater than a factor of 10?
4. Is the range of Species Mean Acute Values for any genus greater than a factor of 10?
5. Is there more than a factor of ten difference between the four lowest Genus Mean Acute Values?
6. Are any of the four lowest Genus Mean Acute Values questionable?

7. Is the Final Acute Value reasonable in comparison with the Species Mean Acute Values and Genus Mean Acute Values?

8. For any commercially or recreationally important species, is the geometric mean of the acute values from flow-through tests in which the concentrations of test material were measured lower than the Final Acute Value?

9. Are any of the chronic values questionable?

10. Are chronic values available for acutely sensitive species?

11. Is the range of acute-chronic ratios greater than a factor of 10?

12. Is the Final Chronic Value reasonable in comparison with the available acute and chronic data?

13. Is the measured or predicted chronic value for any commercially or recreationally important species below the Final Chronic Value?

14. Are any of the other data important?

15. Do any data look like they might be outliers?

16. Are there any deviations from the Guidelines? Are they acceptable?

B. On the basis of all available pertinent laboratory and field information, determine if the criterion is consistent with sound scientific evidence. If it is not, another criterion, either higher or lower, should be derived using appropriate modifications of these Guidelines.

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## *Appendix 1. Resident North American Species of Aquatic Animals Used in Toxicity and Bioconcentation Tests*

### Introduction

These lists identify species of aquatic animals which have reproducing wild populations in North America and have been used in toxicity or bioconcentration tests. "North America" includes only the 48 contiguous states, Canada, and Alaska; Hawaii and Puerto Rico are not included. Saltwater (i.e., estuarine and true marine) species are considered resident in North America if they inhabit or regularly enter shore waters on or above the continental shelf to a depth of 200 meters. Species do not have to be native to be resident. Unlisted species should be considered resident North American species if they can be similarly confirmed or if the test organisms were obtained from a wild population in North America.

The sequence for fishes is taken from A List of Common and Scientific Names of Fishes from the United States and Canada. For other species, the sequence of phyla, classes, and families is taken from the NODC Taxonomic Code, Third Edition, National Oceanographic Data Center, NOAA, Washington, DC 20235, July, 1981, and the numbers given are from that source to facilitate verification. Within a family, genera are in alphabetical order, as are species in a genus.

The references given are those used to confirm that the species is a resident North American species. (The NODC Taxonomic Code contains foreign as well as North American species.) If no such reference could be found, the species was judged to be nonresident. No reference is given for organisms not identified to species; these are considered resident only if obtained from wild North American populations. A few nonresident species are listed in brackets and noted as "nonresident" because they were mistakenly identified as resident in the past or to save other investigators from doing literature searches on the same species.

**Special Note**

This December 2010 electronic version of the 1985 Guidelines serves to meet the requirements of Section 508 of the Rehabilitation Act. While converting the 1985 Guidelines to a 508-compliant version, EPA updated the taxonomic nomenclature to reflect changes that occurred since the tables were originally produced in 1985. The numbers included for Phylum, Class and Family represent those currently in use from the Integrated Taxonomic Information System, or ITIS, and reflect what is referred to in ITIS as Taxonomic Serial Numbers. ITIS replaced the National Oceanographic Data Center (NODC) taxonomic coding system which was used to create the original taxonomic tables included in the 1985 Guidelines document (NODC, Third Addition - see Introduction). For more information on the NODC taxonomic codes, see http://www.nodc.noaa.gov/General/CDR-detdesc/taxonomic-v8.html.

The code numbers included in the reference column of the tables have not been updated from the 1985 version. These code numbers are associated with the old NODC taxonomic referencing system and are simply replicated here for historical purposes. Footnotes may or may not still apply.

EPA is working on a more comprehensive update to the 1985 Guidelines, including new taxonomic tables which better reflect the large number of aquatic animal species known to be propagating in U.S. waters.

## Freshwater Species Table

Synonyms appear after the official Scientific Name and are marked with an asterisk (*).
Non-resident species are noted in the Reference column and are marked with a dagger (†)

| Class | Family | Species | | Reference |
|---|---|---|---|---|
| | | Common Name | Scientific Name | |
| **<u>Phylum: Porifera</u> (46861)** | | | | |
| Demospongiae<br>47528 | Spongillidae<br>47691 | Sponge | _Ephydatia fluviatilis_ | P93 |
| **<u>Phylum: Cnidaria</u> (48738)** | | | | |
| Hydrozoa<br>48739 | Hydridae<br>50844 | Hydra | _Hydra oligactis_ | E318, P112 |
| | | Hydra | _Hydra littoralis_ | E321, P112 |
| **<u>Phylum: Platyhelminthes</u> (53963)** | | | | |
| Turbellaria<br>53964 | Planariidae<br>54502 | Planarian | _Dugesia dorotocephala_ | D22 |
| | | Planarian | _Dugesia lugubris_<br>_Dugesia polychroa_‡ | D24 |
| | | Planarian | _Planaria gonocephala_ | [1] |
| | | Planarian | _Polycelis felina_§ | nonresident |
| | Dendrocoelidae<br>54469 | Planarian | _Procotyla fluviatilis_<br>_Dendrocoelum lacteum_* | E334, P132, D63 |
| **<u>Phylum: Gastrotricha</u> (57597)** | | | | |
| Chaetonotida<br>57822 | Chaetonotidae<br>57823 | Gastrotrich | _Lepidodermella squamata_<br>_Lepidodermella squamatum_* | E413 |
| **<u>Phylum: Rotifera</u> (58239)** | | | | |
| Eurotatoria<br>(Formerly Bdelloidea)<br>654070 | Philodinidae<br>58266 | Rotifer | _Philodina acuticornis_ | Y |
| | | Rotifer | _Philodina roseola_ | E487 |
| Eurotatoria<br>(Formerly Monogononta)<br>654070 | Brachionidae<br>58344 | Rotifer | _Keratella cochlearis_ | E442, P188 |
| | | Rotifer | _Keratella sp._ | [2] |
| **<u>Phylum: Annelida</u> (64357)** | | | | |
| Polychaeta<br>(Formerly Archiannelida)<br>64358 | Aeolosomatidae<br>68423 | Worm | _Aeolosoma headleyi_ | E528, P284 |
| Clitellata<br>(Formerly Oligochaeta)<br>568832 | Lumbriculidae<br>68440 | Worm | _Lumbriculus variegatus_ | E533, P290 |
| | Tubificidae<br>68585 | Tubificid worm | _Branchiura sowerbyi_ | E534, P289, GG |
| | | Tubificid worm | _Limnodrilus hoffmeisteri_ | E536, GG |
| | | Tubificid worm | _Quistadrilus multisetosus_<br>_Peloscolex multisetosus_* | E535, GG |
| | | Tubificid worm | _Rhyacodrilus montanus_ | GG |
| | | Tubificid worm | _Spirosperma ferox_<br>_Peloscolex ferox_* | GG |
| | | Tubificid worm | _Spirosperma nikolskyi_<br>_Peloscolex variegatus_* | E534, GG |
| | | Tubificid worm | _Stylodrilus heringianus_ | GG |

‡ Synonym
§ Non-resident species

| Class | Family | Species | | Reference |
|---|---|---|---|---|
| | | Common Name | Scientific Name | |
| | | Tubificid worm | *Tubifex tubifex* | E536, P289, GG |
| | | Tubificid worm | *Varichaeta pacifica* | GG |
| | Naididae 68854 | Worm | *Nais sp.* | 2 |
| | | Worm | *Paranais sp.* | 2 |
| | | Worm | *Pristina sp.* | 2 |
| Clitellata (Formerly Hirudinea) 568832 | Erpobdellidea 69438 | Leech | *Erpobdella octoculata* | Formerly nonresident (BB16) |
| **<u>Phylum: Mollusca</u> (69458)** | | | | |
| Gastropoda 69459 | Viviparidae 70304 | Snail | *Campeloma decisum* | P731, M216 |
| | Bithyniidae (Amnicolidae) (Bulimidae) (Hydrobiidae) 70745 | Snail | *Amnicola sp.* | 2 |
| | Pleuroceridae 71541 | Snail | *Goniobasis livescens* | P732 |
| | | Snail | *Elimia virginica*<br>*Goniobasis virginica*[*] | E1137 |
| | | Snail | *Leptoxis carinata*<br>*Nitocris carinata*[*]<br>*Mudalia carinata*[*] | X, E1137 |
| | | Snail | *Nitocris sp.* | 2 |
| | Lymnaeidae 76483 | Snail | *Lymnaea acuminata*[†] | nonresident |
| | | Snail | *Lymnaea catascopium*<br>*Lymnaea emerginata*[*]<br>*Stagnicola emerginata*[*] | M328 |
| | | Snail | *Lymnaea elodes*<br>*Lymnaea palustris*[*] | E1127, M351 |
| | | Snail | *Lymnaea luteola*[†] | nonresident M266 |
| | | Snail | *Lymnaea stagnalis* | E1127, P728, M296 |
| | | Snail | *Lymnaea sp.* | 2 |
| | Planorbidae 76591 | Snail | *Biomphalaria glabrata* | Formerly nonresident (M390) |
| | | Snail | *Gyraulus circumstriatus* | P729, M397 |
| | | Snail | *Helisoma campanulatum* | M445 |
| | | Snail | *Helisoma trivolvis* | P729, M452 |
| | Physidae 76676 | Snail | *Aplexa hypnorum* | E1126, P727, M373 |
| | | Snail | *Physa fontinalis*[†] | nonresident M373 |
| | | Snail | *Physa gyrina* | E1126, P727, M373 |
| | | Snail | *Physa heterostropha* | M378 |
| | | Snail | *Physa integra* | P727 |
| | | Snail | *Physa sp.* | 2 |
| Bivalvia (Pelecypoda) 79118 | Margaritiferidae 79914 | Mussel | *Margaritifera margaritifera* | E1138, P748, J11 |
| | Unionidae (Formerly Amblemidae) 79913 | Mussel | *Amblema plicata* | AA122 |
| | Unionidae | Mussel | *Anodonta imbecillis* | J72, AA122 |

| Class | Family | Species | | Reference |
|---|---|---|---|---|
| | | Common Name | Scientific Name | |
| | 79913 | Mussel | *Carunculina parva*<br>*Toxolasma texasensis*[*] | J19, AA122 |
| | | Mussel | *Cyrtonaias tampicoenis* | P759, AA122 |
| | | Mussel | *Elliptio complanata* | J13 |
| | Corbiculidae<br>81381 | Asiatic clam | *Corbicula fluminea* | E1159 |
| | | Asiatic clam | *Corbicula manilensis* | P749 |
| | Pisidiidae<br>Sphaeriidae[*]<br>81388 | Fingernail clam | *Eupera cubensis*<br>*Eupera singleyi*[*] | E1158, P763, G9 |
| | | Fingernail clam | *Musculium transversum*<br>*Sphaerium transversum*[*] | M160, G11 |
| | | Fingernail clam | *Sphaerium corneum* | G12 |
| **<u>Phylum: Arthropoda</u> (82696)** | | | | |
| Branchiopoda<br>(Formerly Crustacea)<br>83687 | Lynceidae<br>83769 | Conchostracan | *Lynceus brachyurus* | E580, P344 |
| | Sididae<br>83834 | Cladoceran | *Diaphanosoma sp.* | 2 |
| | Daphniidae<br>83872 | Cladoceran | *Ceriodaphnia acanthina* | E618 |
| | | Cladoceran | *Ceriodaphnia reticulata* | E618, P368 |
| | | Cladoceran | *Daphnia ambigua* | E607, P369 |
| | | Cladoceran | *Daphnia carinata* | [3] |
| | | Cladoceran | *Daphnia cucullata*[†] | nonresident |
| | | Cladoceran | *Daphnia galeata mendotae* | E610, P370 |
| | | Cladoceran | *Daphnia hyalina* | [4] |
| | | Cladoceran | *Daphnia longispina* | [5] |
| | | Cladoceran | *Daphnia magna* | E605, P367 |
| | | Cladoceran | *Daphnia parvula* | E611 |
| | | Cladoceran | *Daphnia pulex* | E613, P367 |
| | | Cladoceran | *Daphnia pulicaria* | A |
| | | Cladoceran | *Daphnia similis* | E606, P367 |
| | | Cladoceran | *Simocephalus serrulatus* | E617, P370 |
| | | Cladoceran | *Simocephalus vetulus* | E617, P370 |
| | Moinidae<br>(Formerly Daphnidae)<br>84162 | Cladoceran | *Moina macrocopa* | E622, P372 |
| | | Cladoceran | *Moina rectirostris* | E623 |
| | Bosminidae<br>83935 | Cladoceran | *Bosmina longirostris* | E624, P373 |
| | Polyphemidae<br>83959 | Cladoceran | *Polyphemus pediculus* | E599, P385 |
| Ostracoda<br>(Formerly Crustacea)<br>84195 | Cyprididae<br>Cypridae[*]<br>84462 | Ostracod | *Cypretta kawatai*[†] | nonresident<br>U |
| | | Ostracod | *Cypridopsis vidua* | E770, P430 |
| Maxillopoda<br>(Formerly Crustacea)<br>621145 | Diaptomidae<br>85779 | Copepod | *Eudiaptomus padanus*[†] | nonresident |
| | Temoridae<br>85855 | Copepod | *Epischura lacustris* | E751, P407 |
| | Cyclopidae<br>88634 | Copepod | *Cyclops abyssorum*[†] | nonresident |
| | | Copepod | *Cyclops bicuspidatus* | E807, P405 |
| | | Copepod | *Cyclops vernalis* | E804, P405 |
| | | Copepod | *Cyclops viridis*<br>*Acanthocyclops viridis*[*] | E803, P397 |

| Class | Family | Species | | Reference |
|---|---|---|---|---|
| | | Common Name | Scientific Name | |
| | | Copepod | *Acanthocyclops sp.* | 2 |
| | | Copepod | *Diacyclops sp.* | 2 |
| | | Copepod | *Eucyclops agilis* | P403 |
| | | Copepod | *Mesocyclops leuckarti* | E812, P403 |
| Malacostraca<br>(Formerly Crustacea)<br>89787 | Asellidae<br>92657 | Isopod | *Asellus aquaticus*[†] | nonresident (I2) |
| | | Isopod | *Caecidotea bicrenata*<br>*(Formerly Asellus bicrenata)* | HH<br>(I1,2) |
| | | Isopod | *Asellus brevicaudus* | E875, P447, I |
| | | Isopod | *Asellus communis* | E875, P448, I |
| | | Isopod | *Asellus intermedius* | E875, P448, I |
| | | Isopod | *Asellus meridionalis*[†]<br>*Asellus meridianus*[*†] | nonresident |
| | | Isopod | *Asellus racovitzai* | P449, I |
| | | Isopod | *Lirceus alabamae* | P875, I |
| | Crangonyctidae<br>(Formerly Gammaridae)<br>95080 | Amphipod | *Crangonyx pseudogracilis* | P459, T68, FF23 |
| | Gammaridae<br>93745 | Amphipod | *Gammarus fasciatus* | E877, P458, T53 |
| | | Amphipod | *Gammarus lacustris* | E877, P458, FF23 |
| | | Amphipod | *Gammarus pseudolimnaeus* | E877, P458, T48 |
| | | Amphipod | *Gammarus pulex*[†] | nonresident |
| | | Amphipod | *Gammarus tigrinus* | L51, FF17 |
| | | Amphipod | *Gammarus sp.* | 2 |
| | Hyalellidae<br>(Talitridae)<br>94022 | Amphipod | *Hyalella azteca*<br>*Hyalella knickerbockeri*[*] | E876, P457, T154 |
| | Palaemonidae<br>96213 | Prawn | *Macrobrachium lamarrei*[†] | nonresident |
| | | Prawn | *Macrobrachium rosenbergii* | [6] |
| | | Prawn | *Palaemonetes kadiakensis* | E881, P484 |
| | Cambaridae<br>(Formerly Astacidae)<br>97336 | Crayfish | *Cambarus latimanus* | E897 |
| | | Crayfish | *Faxonella clypeata* | E890 |
| | | Crayfish | *Orconectes immunis* | E894, P482 |
| | | Crayfish | *Orconectes limosus* | E893, P482 |
| | | Crayfish | *Orconectes propinquus* | E894, P482 |
| | | Crayfish | *Orconectes nais* | E894 |
| | | Crayfish | *Orconectes rusticus* | E893, P482 |
| | | Crayfish | *Orconectes virilis* | E894, P483 |
| | | Crayfish | *Pacifastacus trowbridgii* | E883 |
| | | Crayfish | *Procambarus acutus* | P482 |
| | | Crayfish | *Procambarus clarki*<br>*Procambarus clarkii*[*] | E885, P482 |
| | | Crayfish | *Procambarus simulans* | E888, P482 |
| | | Crayfish | *Procambarus sp.* | 2 |
| Insecta<br>99208 | Heptageniidae<br>100504 | Mayfly | *Maccaffertium ithaca*<br>*Stenonema ithaca*[*] | S173, O205 |
| | | Mayfly | *Maccaffertium modestum*<br>*Stenonema rubrum*[*] | S178, O205 |
| | Baetidea | Mayfly | *Callibaetis skokianus* | S116, N9 |

| Class | Family | Species | | Reference |
|---|---|---|---|---|
| | | Common Name | Scientific Name | |
| | 100755 | Mayfly | *Callibaetis sp.* | 2 |
| | | Mayfly | *Cloeon dipterum* | O173 |
| | Leptophlebiidae 101095 | Mayfly | *Paraleptophlebia praepedita* | S89, O233 |
| | Ephemerellidae 101232 | Mayfly | *Drunella doddsii* *Ephemerella doddsi** | O245 |
| | | Mayfly | *Drunella grandis* *Ephemerella grandis** | O245 |
| | | Mayfly | *Ephemerella subvaria* | N9, O248, S71 |
| | | Mayfly | *Ephemerella sp.* | 2 |
| | Caenidea 101467 | Mayfly | *Caenis diminuta* | S51, O268 |
| | Ephemeridae 101525 | Mayfly | *Ephemera simulans* | S36, N9, O283 |
| | | Mayfly | *Hexagenia bilineata* | N9, S39, O290 |
| | | Mayfly | *Hexagenia rigida* | O290, S41, N9 |
| | | Mayfly | *Hexagenia sp.* | 2 |
| | Libellulidae 101797 | Dragonfly | *Pantala hymenaea* *Pantala hymenea** | N15, V603 |
| | Coenagrionidae Agrionidae* Coenagriidae* 102077 | Damselfly | *Enallagma aspersum* | DD |
| | | Damselfly | *Ischnura elegans*† | nonresident |
| | | Damselfly | *Ischnura verticalis* | N15, E918 |
| | | Damselfly | *Ischnura sp.* | 2 |
| | Pteronarcyidae (Formerly Pteronarcidae) Pleronarcyidae* 102470 | Stonefly | *Pteronarcella badia* | L172 |
| | | Stonefly | *Pteronarcys californica* | L173 |
| | | Stonefly | *Pteronarcys dorsata* | E947 |
| | | Stonefly | *Pteronarcys sp.* | 2 |
| | Nemouridae 102517 | Stonefly | *Nemoura cinerea*† | nonresident |
| | Perlidae 102914 | Stonefly | *Acroneuria lycorias* | N4, E953 |
| | | Stonefly | *Acroneuria pacifica* | E953, L180 |
| | | Stonefly | *Claassenia sabulosa* | E953 |
| | | Stonefly | *Agnetina capitata* *Neophasganophora capitata** *Phasganophora capitata** | E953, CC407 |
| | Perlodidae 102994 | Stonefly | *Skwala americana* *Arcynopteryx parallela** | E954 |
| | Nepidae 103747 | Water Scorpion | *Ranatra elongate*† (Species cannot be confirmed in ITIS) | nonresident |
| | Dytiscidae 111963 | Beetle | - | 2 |
| | Elmidae Elminthidae* 114093 | Beetle | *Stenelmis sexlineata* | W21 |
| | Hydropsychidae 115398 | Caddisfly | *Arctopsyche grandis* | L251, II98 |
| | | Caddisfly | *Hydropsyche betteni* | N24 |
| | | Caddisfly | *Hydropsyche californica* | L253 |
| | | Caddisfly | *Hydropsyche sp.* | 2 |
| | Limnephilidae 115933 | Caddisfly | *Clistoronia magnifica* | II206 |
| | | Caddisfly | *Philarctus quaeris* | II272 |

| Class | Family | Species | | Reference |
|---|---|---|---|---|
| | | Common Name | Scientific Name | |
| | Brachycentridae<br>116905 | Caddisfly | *Brachycentrus sp.* | 2 |
| | Tipulidae<br>118840 | Crane fly | *Tipula sp.* | 2 |
| | Ceratopogonidae<br>127076 | Biting midge | - | 2 |
| | Culicidae<br>125930 | Mosquito | *Aedes aegypti* | EE3 |
| | | Mosquito | *Culex pipiens* | EE3 |
| | Chironomidae<br>127917 | Midge | *Chironomus plumosus*<br>*Tendipas plumosus*[*] | L423 |
| | | Midge | *Chironomus tentans* | Q |
| | | Midge | *Chironomus thummi*[†] | nonresident |
| | | Midge | *Chironomus sp.* | 2 |
| | | Midge | *Paratanytarsus parthenogeneticus* | [7] |
| | | Midge | *Paratanytarsus dissimilis*<br>*Tanytarsus dissimilis*[*] | R11 |
| | Athericidae<br>(Formerly Rhagionidae)<br>Leptidae[*]<br>130928 | Snipe fly | *Atherix sp.* | 2 |
| **<u>Phylum: Ectoprocta</u> (155470)** | | | | |
| Phylactolaemata<br>156688 | Pectinatellidae<br>(Formerly<br>Pectinatelcidae)<br>156729 | Bryozoan | *Pectinatella magnifica* | E502, P269 |
| | Lophopodidae<br>156714 | Bryozoan | *Lophopodella carteri* | E502, P2671 |
| | Plumatellidae<br>156690 | Bryozoan | *Plumatella emarginata* | E505, P272 |
| **<u>Phylum: Chordata</u> (158852)** | | | | |
| Agnatha<br>159693 | Petromyzontidae<br>159697 | Sea lamprey | *Petromyzon marinus* | F11 |
| Actinopterygii<br>(Formerly Osteichthyes)<br>161061 | Anguillidae<br>161125 | American eel | *Anguilla rostrata* | F15 |
| | Salmonidae<br>161931 | Pink salmon | *Oncorhynchus gorbuscha* | F18 |
| | | Coho salmon | *Oncorhynchus kisutch* | F18 |
| | | Sockeye salmon | *Oncorhynchus nerka* | F19 |
| | | Chinook Salmon | *Oncorhynchus tshawytscha* | F19 |
| | | Mountain whitefish | *Prosopium williamsoni* | F19 |
| | | Golden Trout | *Oncorhynchus aguabonita*<br>(Formerly *Salmo aguabonita)* | F19 |
| | | Cutthroat trout | *Oncorhynchus clarki*<br>(Formerly *Salmo clarki)* | F19 |
| | | Rainbow trout<br>Steelhead trout[*] | *Oncorhynchus mykiss*<br>(Formerly *Salmo gairdneri)* | F19 |
| | | Atlantic salmon | *Salmo salar* | F19 |
| | | Brown trout | *Salmo trutta* | F19 |
| | | Brook trout | *Salvelinus fontinalis* | F19 |
| | | Lake trout | *Salvelinus namaycush* | F19 |

| Class | Family | Species | | Reference |
|---|---|---|---|---|
| | | Common Name | Scientific Name | |
| | Esocidae 162137 | Northern pike | *Esox lucius* | F20 |
| | Cyprinidae 163342 | Chiselmouth | *Acrocheilus alutaceus* | F21 |
| | | Longfin dace | *Agosia chrysogaster* | F21 |
| | | Central stoneroller | *Campostoma anomalum* | F21 |
| | | Goldfish | *Carassius auratus* | F21 |
| | | Common carp | *Cyprinus carpio* | F21 |
| | | Zebra danio<br>Zebrafish* | *Danio rerio*†<br>*Brachydanio rerio**† | nonresident<br>F96 |
| | | Silverjaw minnow | *Notropis buccatus*<br>*Ericymba buccata** | F21 |
| | | Golden shiner | *Notemigonus crysoleucas* | F23 |
| | | Pugnose shiner | *Notropis anogenus* | F23 |
| | | Emerald shiner | *Notropis atherinoides* | F23 |
| | | Striped shiner | *Luxilus chrysocephalus*<br>*Notropis chrysocephalus** | F23 |
| | | Common shiner | *Luxilus cornutus*<br>*Notropis cornutus** | F23 |
| | | Pugnose minnow | *Opsopoeodus emiliae*<br>*Notropis emiliae** | F24 |
| | | Spottail shiner | *Notropis hudsonius* | F24 |
| | | Red shiner | *Cyprinella lutrensis*<br>*Notropis lutrensis** | F24 |
| | | Spotfin shiner | *Cyprinella spiloptera*<br>*Notropis spilopterus** | F25 |
| | | Sand shiner | *Notropis stramineus* | F25 |
| | | Steelcolor shiner | *Cyprinella whipplei*<br>*Notropis whipplei** | F25 |
| | | Northern redbelly dace | *Phoxinus eos* | F25 |
| | | Bluntnose minnow | *Pimephales notatus* | F25 |
| | | Fathead minnow | *Pimephales promelas* | F25 |
| | | Northern squawfish | *Ptychocheilus oregonensis* | F25 |
| | | Blacknose dace | *Rhinichthys atratulus* | F25 |
| | | Speckled dace | *Rhinichthys osculus* | F25 |
| | | Bitterling | *Rhodeus sericeus* | F26 |
| | | Rudd | *Scardinius erythrophthalmus* | F26 |
| | | Creek chub | *Semotilus atromaculatus* | F26 |
| | | Pearl dace | *Margariscus margarita*<br>*Semotilus margarita** | F26 |
| | | Tench | *Tinca tinca* | F26 |
| | Catostomidae 163892 | White sucker | *Catostomus commersoni* | F26 |
| | | Mountain sucker | *Catostomus platyrhynchus* | F26 |
| | Ictaluridae 163995 | Black bullhead | *Ameiurus melas*<br>*Ictalurus melas** | F27 |
| | | Yellow bullhead | *Ameiurus natalis*<br>*Ictalurus natalis** | F27 |
| | | Brown bullhead | *Ameiurus nebulosus*<br>*Ictalurus nebulosus** | F27 |
| | | Channel catfish | *Ictalurus punctatus* | F27 |

| Class | Family | Species | | Reference |
|---|---|---|---|---|
| | | Common Name | Scientific Name | |
| | Clariidae 164118 | Walking catfish | *Clarias batrachus* | F28 |
| | Adrianichthyidae (Formerly Oryziidae) 165623 | Medaka | *Oryzias latipe*† | nonresident F96 |
| | Cyprinodontidae 165629 | Banded killifish | *Fundulus diaphanus* | F33 |
| | | Flagfish | *Jordanella floridae* | F33 |
| | Poeciliidae 165876 | Mosquitofish | *Gambusia affinis* | F33 |
| | | Amazon molly | *Poecilia formosa* | F34 |
| | | Sailfin molly | *Poecilia latipinna* | F34 |
| | | Molly | *Poecilia sp.* | |
| | | Guppy | *Poecilia reticulata (Lebistes reticulatus, Obs.)* | F34 |
| | | Southern platyfish | *Xiphophorus maculatus* | F34 |
| | Gasterosteidae 166363 | Brook stickleback | *Culaea inconstans* | F35 |
| | | Threespine stickleback | *Gasterosteus aculeatus* | F35 |
| | | Ninespine stickleback | *Pungitius pungitius* | F35 |
| | Percichthyidae 170315 | White perch | *Morone americana (Roccus americanus, Obs.)* | F36 |
| | | Striped bass | *Morone saxatilis (Roccus saxatilis, Obs.)* | F36 |
| | Centrarchidae 168093 | Rock bass | *Ambloplites rupestris* | F38 |
| | | Green sunfish | *Lepomis cyanellus* | F38 |
| | | Pumpkinseed | *Lepomis gibbosus* | F38 |
| | | Orangespotted sunfish | *Lepomis humilis* | F38 |
| | | Bluegill | *Lepomis macrochirus* | F38 |
| | | Longear sunfish | *Lepomis megalotis* | F38 |
| | | Redear sunfish | *Lepomis microlophus* | F38 |
| | | Smallmouth bass | *Micropterus dolomieui* | F39 |
| | | Largemouth bass | *Micropterus salmoides* | F39 |
| | | White crappie | *Pomoxis annularis* | F39 |
| | | Black crappie | *Pomoxis nigromaculatus* | F39 |
| | Percidae 168356 | Rainbow darter | *Etheostoma caeruleum* | F39 |
| | | Johnny darter | *Etheostoma nigrum* | F40 |
| | | Orangethroat darter | *Etheostoma spectabile* | F40 |
| | | Yellow perch | *Perca flavescens* | F41 |
| | | Walleye | *Sander vitreus* *Stizostedion vitreum vitreum** | F41 |
| | Sciaenidae 169237 | Freshwater drum | *Aplodinotus grunniens* | F45 |
| | Cichlidae 169770 | Oscar | *Astronotus ocellatus* | F47 |
| | | Blue tilapia | *Tilapia aurea* | F47 |
| | | Mozambique tilapia | *Oreochromis mossambicus* *Tilapia mossambica** | F47 |
| | Cottidae 167196 | Mottled sculpin | *Cottus bairdi* | F60 |
| Amphibia 173420 | Ranidae 173433 | Bullfrog | *Rana catesbeiana* | B206 |
| | | Green frog | *Rana clamitans* | B206 |

| Class | Family | Species | | Reference |
|---|---|---|---|---|
| | | Common Name | Scientific Name | |
| | | Pig frog | *Lithobates grylio*<br>*Rana grylio*[*] | B206 |
| | | River frog | *Rana heckscheri* | B206 |
| | | Leopard frog | *Rana pipiens* | B205 |
| | | Wood frog | *Rana sylvatica* | B206 |
| | | Frog | *Rana temporia*[†] | nonresident |
| | | Leopard frog | *Lithobates sphenocephalus sphenocephalus*<br>(Formerly *Rana spenocephala)* | JJ |
| | Microhylidae<br>173465 | Eastern narrow-mouthed toad | *Gastrophryne carolinensis* | B192 |
| | Bufonidae<br>173471 | American toad | *Anaxyrus americanus americanus*<br>*Bufo americanus*[*] | B196 |
| | | Toad | *Bufo bufo*[†] | nonresident |
| | | Green toad | *Anaxyrus debilis debilis*<br>*Bufo debilis*[*] | B197 |
| | | Fowler's toad | *Anaxyrus fowleri*<br>*Bufo fowleri*[*] | B196 |
| | | Red-spotted toad | *Anaxyrus punctatus*<br>*Bufo punctatus*[*] | B198 |
| | | Woodhouse's toad | *Anaxyrus woodhousii woodhousii*<br>*Bufo woodhousii*[*] | B196 |
| | Hylidae<br>173497 | Northern cricket frog | *Acris crepitans* | B203 |
| | | Southern gray treefrog | *Hyla chrysoscelis* | B201 |
| | | Spring creeper | *Pseudacris crucifer*<br>*Hyla crucifer*[*] | B202 |
| | | Barking treefrog | *Hyla gratiosa* | B201 |
| | | Squirrel treefrog | *Hyla squirella* | B201 |
| | | Gray treefrog | *Hyla versicolor* | B200 |
| | | Northern chorus frog | *Pseudacris triseriata* | B202 |
| | Pipidae<br>173547 | African clawed frog | *Xenopus laevis* | Z16 |
| | Ambystomatidae<br>173588 | Spotted salamander | *Ambystoma maculatum* | B176 |
| | | Mexican axolotl | *Ambystoma mexicanum*[†] | nonresident |
| | | Marbled salamander | *Ambystoma opacum* | B176 |
| | Salamandridae<br>173613 | Newt | *Notophthalmus viridescens*<br>*Triturus viridescens*[*] | B179 |

## Footnotes for Freshwater Species

[1] Apparently this is an outdated name (D19, 20). Organisms identified as such should only be used if they were obtained from North America.

[2] Apparently this is an outdated name (D19, 20). Organisms identified as such should only be used if they were obtained from North America.

[3] If from North America, it is resident and should be called *D. similis* (C). If not from North America, it should be considered nonresident.

[4] If from North America, it is resident and may be any one of a number of species such as *D. laevie*, *D. dubia*, or *D. galeate mendoca* (C). If not from North America, it should be considered nonresident.

5 If from North America, it is resident and may be any one of a number of species such as *D. ambigua*, *D. longiremis*, or *D. rosea* (C). If not from North America, it should be considered nonresident.

6 This species might be established in portions of the southern United States.

7 The taxonomy of this species and this and similar genera has not been clarified, but this species should be considered resident.

## References for Freshwater Species


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## Saltwater Species Table

Synonyms appear after the official Scientific Name and are marked with an asterisk (*).
Non-resident species are noted in the Reference column and are marked with a dagger (†)

| Class | Family | Species | | Reference |
|---|---|---|---|---|
| | | Common Name | Scientific Name | |
| **Phylum: Cnidaria (Coelenterata) (48738)** | | | | |
| Hydroza 48739 | Campanulariidae 49470 | Hydroid | *Campanularia flexiosa* *Campanularia flexuosa*** | B122, E81 |
| | | Hydroid | *Laomedea loveni*†† | nonresident |
| | | Hydromedusa | *Phialidium sp.* | [1] (E81) |
| | Campanulinidae 49756 | Hydroid | *Eirene viridula*† | nonresident |
| **Phylum: Ctenophora (53856)** | | | | |
| Tentaculata 53858 | Pleurobrachiidae 53860 | Ctenophore | *Pleurobrachia pileus* | B218, E162 |
| | Mnemiidae 53915 | Ctenophore | *Mnemiopsis mccradyi* | C39, I94 |
| **Phylum: Nemertea (Rhynchocoela) (57411)** | | | | |
| Heteronemertea 57438 | Lineidae 57443 | Nemertine worm | *Cerebratulus fuscus* | B252 |
| **Phylum: Rotifera (Rotatoria) (58239)** | | | | |
| Monogononta 58342 | Brachionidae 58344 | Rotifer | *Brachionus plicatilis* | B272 |
| **Phylum: Annelida (64357)** | | | | |
| Polychaeta 64358 | Phyllodocidae 65228 | Polychaete worm | *Phyllodoce maculata* *Anaitides maculata** *Nereiphylla maculata** | E334 |
| | Nereididae (Nereidae) 65870 | Polychaete worm | *Neanthes arenaceodentata* *Nereis arenaceodentata** | E377 |
| | | Polychaete worm | *Neanthes vaali*† | nonresident |
| | | Polychaete worm | *Nereis diversicolor* *Neanthes diversicolor** | E337, F527 |
| | | Sand worm | *Nereis virens* *Neanthes virens** | B317, E337, C58 |
| | | Polychaete worm | *Nereis sp.* | |
| | Dorvilleidae 66478 | Polychaete worm | *Ophryotrocha diadema* | P23 |
| | | Polychaete worm | *Ophryotrocha labronica*† *Ophryotrocha labrunica**† | nonresident |
| | Spionidae 66781 | Polychaete worm | *Polydora websteri* | E338 |
| | Cirratulidae 67116 | Polychaete worm | *Cirriformia spirabranchia* | G253 |
| | Ctenodrilidae 67217 | Polychaete worm | *Ctenodrilus serratus* | G275 |
| | Capitellidae 67413 | Polychaete worm | *Capitella capitata* | B358, E337 |
| | Arenicolidae 67500 | Polychaete worm | *Arenicola marina* | B369, E337 |

** Synonym
†† Non-resident species

| Class | Family | Species | | Reference |
|---|---|---|---|---|
| | | Common Name | Scientific Name | |
| | Sabellidae<br>68076 | Polycheate worm | *Eudistylia vancouveri* | DD |
| Oligochaeta<br>68422 | Tubificidae<br>68585 | Oligochaete worm | *Limnodriloides verrucosus* | Z |
| | | Oligochaete worm | *Monopylephorus cuticulatus* | Z |
| | | Oligochaete worm | *Peloscolex gabriellae*<br>*Tubificoides gabriellae*[*] | Z |
| **Phylum: Mollusca (69458)** | | | | |
| Gastropoda<br>69459 | Haliotididae<br>566897 | Black abalone | *Haliotis cracherodii* | C88, D17 |
| | | Red abalone | *Haliotis rufescens* | D18 |
| | Calyptraeidae<br>72611 | Common Atlantic slippershell | *Crepidula fornicata* | C90, D141 |
| | Muricidae<br>73236 | Oyster drill | *Urosalpinx cinerea*<br>*Urosalpinx cinereus*[*] | B646, D179, E264 |
| | Melongenidae<br>(Neptuneidae)<br>74069 | Channeled whelk | *Busycotypus canaliculatus*<br>*(Formerly Busycon canaliculatum)* | B655, D223, E264 |
| | Nassariidae<br>(Nassidae)<br>74102 | Mud snail | *Nassarius obsoletus*<br>*Nassa obsoleta*[*]<br>*Icyanassa obsoleta*[*] | B649, D226, E264 |
| Bivalvia<br>(Pelecypoda)<br>79118 | Mytilidae<br>79451 | Northern horse mussel | *Modiolus modiolus* | D434 |
| | | Blue mussel | *Mytilus edulis* | B566, C101, D428, E299 |
| | | Mediterranean mussel | *Mytilus galloprovincialis*[†] | nonresident |
| | Pectinidae<br>79611 | Bay scallop | *Argopecten irradians* | D447 |
| | Ostreidae<br>79866 | Pacific oyster | *Crassostrea gigas* | C102, D456, E300 |
| | | Eastern oyster | *Crassostrea virginica* | D456, E300 |
| | | Oyster | *Crassostrea sp.* | 1 |
| | | Oyster | *Ostrea edulis* | E300 |
| | Cardiidae<br>80865 | Cockle | *Cerastoderma edule*[†]<br>*Cardium edule*[*†] | nonresident |
| | Mactridae<br>80942 | Clam | *Mulinia lateralis* | D491 |
| | | Common rangia | *Rangia cuneata* | D491, E301 |
| | | Surf clam | *Spisula solidissima* | B599, D489, E301 |
| | Tellinidae<br>81032 | Clam | *Macoma inquinata* | D507 |
| | | Bivalve | *Tellina tenuis*[†] | nonresident |
| | Veneridae<br>81439 | Quahog clam | *Mercenaria mercenaria* | D523, E301 |
| | | Common Pacific littleneck | *Protothaca staminea* | D526 |
| | | Japanese littleneck clam | *Tapes philippinarum* | D527 |
| | Myidae<br>81688 | Soft-shell clam | *Mya arenaria* | B602, D536, E302 |
| **Phylum: Arthropoda (82696)** | | | | |
| Merostomata<br>82698 | Limulidae<br>82701 | Horseshoe crab | *Limulus polyphemus* | B533, E403, H30 |
| Branchiopoda<br>(Formerly Crustacea)<br>83687 | Artemiidae<br>83689 | Brine shrimp | *Artemia salina*[†] | [2]<br>nonresident |
| Maxillopoda<br>(Formerly Crustacea)<br>621145 | Calanidae<br>85259 | Copepod | *Calanus helgolandicus* | Q25 |
| | | Copepod | *Undinula vulgaris* | Q29 |
| | Eucalanidae<br>85299 | Copepod | *Eucalanus elongatus* | AA |
| | | Copepod | *Subeucalanus pileatus*<br>*Eucalanus pileatus*[*] | AA |
| | Pseudocalanidae<br>85351 | Copepod | *Pseudocalanus minutus* | E447, I155, Q43 |

| Class | Family | Species | | Reference |
|---|---|---|---|---|
| | | Common Name | Scientific Name | |
| | Euchaetidae 85524 | Copepod | *Euchaeta marina* | Q63 |
| | Metridinidae (Formerly Metridiidae) 593501 | Copepod | *Metridia pacifica* | X179, Y |
| | Pseudodiaptomidae 85847 | Copepod | *Pseudodiaptomus coronatus* | E447, I154, Q101 |
| | Temoridae 85855 | Copepod | *Eurytemora affinis* | E450, I155, Q111 |
| | Pontellidae 86038 | Copepod | *Labidocera scotti* | R157 |
| | Acartiidae 86083 | Copepod | *Acartia clausi* | E447 |
| | | Copepod | *Acartia tonsa* | E447, I154 |
| | Harpacticidae 86329 | Copepod | *Tigriopus californicus* | J78 |
| | | Copepod | *Tigriopus japanicus*† | nonresident |
| | Tisbidae 86444 | Copepod | *Tisbe holothuriae* | BB |
| | Ameiridae (Formerly Canthocamptidae) 86999 | Copepod | *Nitokra spinipes*<br>*Nitocra spinipe** | Q240 |
| | Archaeobalanidae (Formerly Balanidae) 89681 | Barnacle | *Semibalanus balanoides*<br>*Balanus balanoides** | B424, E457 |
| | Balanidae 89599 | Barnacle | *Balanus crenatus* | B426, E457 |
| | | Barnacle | *Balanus eburneus* | B424, E457 |
| | | Barnacle | *Balanus improvisus* | B426, E457 |
| Malacostraca (Formerly Crustacea) 89787 | Mysidae 89856 | Mysid | *Heteromysis formosa* | E513, K720 |
| | | Mysid | *Americamysis bahia*<br>*Mysidopsis bahia** | U173 |
| | | Mysid | *Americamysis bigelowi*<br>*Mysidopsis bigelowi** | E513, K720 |
| | | Mysid | *Neomysis sp.* | 1 |
| | Idoteidae 92564 | Isopod | *Idotea balthica*<br>*Idothea baltica** | B446, E483 |
| | | Isopod | *Idotea emarginata*† | nonresident |
| | | Isopod | *Idotea neglecta*† | nonresident |
| | Janiridae 92810 | Isopod | *Jaera albifrons*† | nonresident |
| | | Isopod | *Jaera albifrons sensu*† | nonresident |
| | | Isopod | *Jaera nordmanni*† | nonresident |
| | Ampeliscidae 93320 | Amphipod | *Ampelisca abdita* | E488, L136 |
| | Eusiridae (Pontogeneiidae) 93681 | Amphipod | *Pontogeneia sp.* | 1 |
| | Gammaridae 93745 | Amphipod | *Gammarus duebeni* | L56 |
| | | Amphipod | *Gammarus oceanicus* | E489, L50 |
| | | Amphipod | *Gammarus tigrinus* | L51 |
| | | Amphipod | *Gammarus zaddachi*† | nonresident |
| | | Amphipod | *Marinogammarus obtusatus* | L58 |
| | Uristadae (Formerly Lysianassidae) 621432 | Amphipod | *Anonyx sp.* | 1 |
| | Euphausiidae (Thysanopodidae) 95500 | Euphausiid | *Euphausia pacifica* | M15 |
| | Penaeidae | Brown shrimp | *Penaeus aztecus* | E518, N17 |

| Class | Family | Species | | Reference |
|---|---|---|---|---|
| | | Common Name | Scientific Name | |
| | 95602 | Pink shrimp | *Penaeus duorarum* | E518, N17 |
| | | White shrimp | *Penaeus setiferus* | E518, N17 |
| | | Blue Shrimp | *Penaeus stylirostris*† | nonresident |
| | Palaemonidae 96213 | Shrimp | *Leander paucidens*† | nonresident |
| | | Prawn | *Leander squilla*†<br>*Palaemon elegans**† | nonresident |
| | | Prawn | *Macrobrachium rosenbergii* | [3] |
| | | Korean shrimp | *Palaemon macrodactylus* | T380 |
| | | Grass shrimp | *Palaemonetes pugio* | E521, N59 |
| | | Grass shrimp | *Palaemonetes vulgaris* | B500, E521, N56 |
| | Hippolytidae 96746 | Sargassum shrimp | *Latreutes fucorum* | N78 |
| | Pandalidae 96965 | Coon stripe shrimp | *Pandalus danae* | T306, W163 |
| | | Shrimp | *Pandalus goniurus* | W163 |
| | | Pink shrimp | *Pandalus montagui* | B494, E522, W163 |
| | Crangonidae 97106 | Sand shrimp | *Crangon crangon*† | nonresident |
| | | Bay shrimp | *Crangon franciscorum*<br>*Crago franciscorum** | V176, W164 |
| | | Shrimp | *Crangon nigricauda* | V176, W164 |
| | | Sand shrimp | *Crangon septemspinosa* | B500, E522 |
| | Nephropidae (Homaridae) 97307 | American lobster | *Homarus americanus* | B502, E532 |
| | | European lobster | *Homarus gammarus*† | nonresident |
| | Paguridae 97774 | Hermit crab | *Pagurus longicarpus* | B514, E537, N125 |
| | Cancridae 98670 | Rock crab | *Cancer irroratus* | B518, E543, N175 |
| | | Dungeness crab | *Cancer magister* | T166, V185, W177 |
| | Portunidae 98689 | Blue crab | *Callinectes sapidus* | B521, C80, E543, N168 |
| | | Green crab | *Carcinus maenas* | C80, E543 |
| | Xanthidae (Pilumnidae) 98748 | Mud crab | *Eurypanopeus depressus* | B522, E543, N195 |
| | | Crab | *Leptodius floridanus* | S80 |
| | | Mud crab | *Rhithropanopeus harrisii* | E543, N187 |
| | Varunidae (formerly Grapsidae) 621521 | Shore crab | *Hemigrapsus nudus* | CC |
| | | Shore crab | *Hemigrapsus oregonensis* | CC |
| | Sesarmidae (formerly Grapsidae) 621520 | Drift line crab | *Armases cinereum*<br>*(Sesarma cinereum)* | B526, E544, N222 |
| | | Crab | *Sesarma haematocheir*† | nonresident |
| | Ocypodidae 99080 | Fiddler crab | *Uca pugilator* | B526, E544, N232 |
| **Phylum: Echinodermata (156857)** | | | | |
| Asteroidea 156862 | Asteriidae 157212 | Starfish | *Asterias forbesi* | B728, E578, O392 |
| Ophiuroidea 157325 | Ophiothricidae 157792 | Brittle star | *Ophiothrix spiculata* | O672, T526 |
| Echinoidea 157821 | Arbaciidae 157904 | Sea urchin | *Arbacia lixula*† | nonresident |
| | | Sea urchin | *Arbacia punctulata* | B762, E572 |
| | Toxopneustidae 157919 | Sea urchin | *Lytechinus pictus* | T253 |
| | | Sea urchin | *Pseudocentrotus depressus*† | nonresident |
| | Echinidae 157940 | [chinoderm | *Paracentrotus lividus*† | nonresident |
| | Echinometridae 157955 | Coral reef echinoid | *Echinometra mathaei*† | nonresident [Hawaii only] |

| Class | Family | Species | | Reference |
|---|---|---|---|---|
| | | Common Name | Scientific Name | |
| | Strongylocentrotidae 157965 | Sea urchin | *Strongylocentrotus purpuratus* | O574, T202 |
| | Dendrasteridae 158008 | Sand dollar | *Dendraster excentricus* | O537, V363 |
| **<u>Phylum: Chaetognatha</u> (158650)** | | | | |
| Sagittoidea 158655 | Sagittidae 158726 | Arrow worm | *Ferosagitta hispida* *Sagitta hispida*[*] | E218 |
| **<u>Phylum: Chordata</u> (158852)** | | | | |
| Chondrichthyes 159785 | Rajidae 160845 | Thornback ray | *Raja clavata*[†] | nonresident |
| Actinopterygii (Formerly Osteichthyes) 161061 | Anguillidae 161125 | American eel | *Anguilla rostrata* | A15 |
| | Clupeidae 161700 | Atlantic menhaden | *Brevoortia tyrannus* | A17 |
| | | Gulf menhaden | *Brevoortia patronus* | A17 |
| | | Atlantic herring | *Clupea harengus* *Clupea harengus harengus*[*] | A17 |
| | | Pacific herring | *Clupea pallasii* *Clupea harengus pallasii*[*] | A17 |
| | | Herring | *Clupea harengus* | A17 |
| | Engraulidae 553173 | Northern anchovy | *Engraulis mordax* | A18 |
| | | Nehu | *Encrasicholina purpurea*[†] *tolephorus purpureus*[*†] | nonresident [Hawaii only] |
| | Salmonidae 161931 | Pink salmon | *Oncorhynchus gorbuscha* | A18 |
| | | Chum salmon | *Oncorhynchus keta* | A18 |
| | | Coho salmon | *Oncorhynchus kisutch* | A18 |
| | | Sockeye salmon | *Oncorhynchus nerka* | A19 |
| | | Chinook salmon | *Oncorhynchus tshawytscha* | A19 |
| | | Rainbow trout (Steelhead trout) | *Oncorhynchus mykiss* (Formerly *Salmo gairdneri)* | A19 |
| | | Atlantic salmon | *Salmo salar* | A19 |
| | Gadidae 164701 | Atlantic cod | *Gadus morhua* | A30 |
| | | Haddock | *Melanogrammus aeglefinus* | A30 |
| | Cyprinodontidae 165629 | Sheepshead minnow | *Cyprinodon variegatus* | A33 |
| | | Mummichog | *Fundulus heteroclitus* | A33 |
| | | Striped killifish | *Fundulus majalis* | A33 |
| | | Longnose killifish | *Fundulus similis* | A33 |
| | Poeciliidae 165876 | Mosquitofish | *Gambusia affinis* | A33 |
| | | Sailfin molly | *Poecilia latipinna* | A34 |
| | Atherinidae 165984 | Inland silverside | *Menidia beryllina* | A34 |
| | | Atlantic silverside | *Menidia menidia* | A34 |
| | | Tidewater silverside | *Menidia peninsulae* | A34 |
| | Gasterosteidae 166363 | Threespine stickleback | *Gasterosteus aculeatus* | A35 |
| | | Fourspine stickleback | *Apeltes quadracus* | A35 |
| | Syngnathidae 166443 | Northern pipefish | *Syngnathus fuscus* | A36 |
| | Percichthyidae 170315 | Striped bass | *Morone saxatilis* *(Roccus saxatilis, Obs.)* | A36 |
| | Kuhliidae 168083 | Mountain bass | *Kuhlia sandvicensis*[†] | nonresident [Hawaii only] |
| | Carangidae 168584 | Florida Pompano | *Trachinotus carolinus* | A43 |

| Class | Family | Species | | Reference |
|---|---|---|---|---|
| | | Common Name | Scientific Name | |
| | Sparidae 169180 | Pinfish | *Lagodon rhomboides* | A45 |
| | Sciaenidae 169237 | Spot | *Leiostomus xanthurus* | A46 |
| | | Atlantic croaker | *Micropogonias undulatus* | A46 |
| | | Red drum | *Sciaenops ocellatus* | A46 |
| | Embiotocidae 169735 | Shiner perch | *Cymatogaster aggregata* | A47 |
| | | Dwarf perch | *Micrometrus minimus* | A48 |
| | Pomacentridae 170044 | Blacksmith | *Chromis punctipinnis* | A48 |
| | Labridae 170477 | Cunner | *Tautogolabrus adspersus* | A49 |
| | | Bluehead | *Thalassoma bifasciatum* | A49 |
| | Mugilidae 170333 | Mullet | *Aldrichetta forsteri*† | nonresident |
| | | Striped mullet | *Mugil cephalus* | A49 |
| | | White mullet | *Mugil curema* | A49 |
| | Ammodytidae 171670 | Pacific sand lance | *Ammodytes hexapterus* | A53 |
| | Gobiidae 171746 | Longjaw mudsucker | *Gillichthys mirabilis* | A54 |
| | | Naked goby | *Gobiosoma bosci* | A54 |
| | Cottidae 167196 | Tidepool sculpin | *Oligocottus maculosus* | A61 |
| | Bothidae 172714 | Speckled sanddab | *Citharichthys stigmaeus* | A64 |
| | | Summer Flounder | *Paralichthys dentatus* | A64 |
| | Pleuronectidae 172859 | Dab | *Limanda limanda*† | nonresident |
| | | Plaice | *Pleuronectes platessa*† | nonresident |
| | | English sole | *Parophrys vetulus* | A65 |
| | | Winter flounder | *Pseudopleuronectes americanus* | A65 |
| | Balistidae 173128 | Planehead filefish | *Monacanthus hispidus* | A66 |
| | Tetraodontidae 173283 | Northern puffer | *Sphoeroides maculatus* | A66 |

## Footnotes for Saltwater Species

[1] Organisms not identified to species are considered resident only if obtained from wild populations in North America.

[2] This species should not be used because it might be too atypical.

[3] This species might be established in portions of the southern United States.

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## *Appendix 2. Example Calculation of Final Acute Value, Computer Program, and Printouts*

### A. Example Calculation

N = total number of MAVs in data set = 8

| **Rank** | **MAV** | **ln(MAV)** | **ln(MAV)$^2$** | **P = R / (N+1)** | $\sqrt{P}$ |
|---|---|---|---|---|---|
| 4 | 6.4 | 1.8563 | 3.4458 | 0.44444 | 0.66667 |
| 3 | 6.2 | 1.8245 | 3.3290 | 0.33333 | 0.57735 |
| 2 | 4.8 | 1.5686 | 2.4606 | 0.22222 | 0.47140 |
| 1 | 0.4 | -0.9163 | 0.8396 | 0.11111 | 0.33333 |
| Sum | | 4.3331 | 10.0750 | 1.11110 | 2.04875 |

$$S^2 = \frac{10.0750 - (4.3331)^2 / 4}{1.11110 - (2.04875)^2 / 4} = 87.134$$

$S = 9.3346$

$L = [\, 4.3331 - (9.3346)(2.04875)] / 4 = -3.6978$

$A = (9.3346)\,(\sqrt{0.05}\,) - 3.6978 = -1.6105$

$FAV = e^{-1.6105} = 0.1998$

### B. Example Computer Program in BASIC Language for Calculating the FAV

```
10     REM This program calculates the FAV when there are less than
20     REM 59 MAVs in the data set
30     X = 0
40     X2 = 0
50     Y = 0
60     Y2 = 0
70     PRINT "How many MAVs are in the data set?"
80     INPUT N
90     PRINT "What are the four lowest MAVs?"
100    FOR R = 1 TO 4
110          INPUT V
```

```
120         X = X + LOG(V)
130         X2 = X2 + (LOG(V)) * (LOG(V))
140         P = R / (N + 1)
150         Y2 = Y2 + P
160         Y = Y + SQR((X2 – X * X / 4))
170   NEXT R
180   S = SQR((X2 – X * X / 4) / (Y2 – Y * Y / 4))
190   L = (X – S * Y) / 4
200   A = S * SQR(0.05) + L
210   F = EXP(A)
220   PRINT "FAV = " F
230   END
```

### C. Example Printouts from Program

```
How many MAVs are in the data set?
? 8
What are the four lowest MAVs?
? 6.4
? 6.2
? 4.8
? .4
FAV = 0.1998
```

```
How many MAVs are in the data set?
? 16
What are the four lowest MAVs?
? 6.4
? 6.2
? 4.8
? .4
FAV = 0.4365
```

# Exhibit 3

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF

CECW-OR

17 AUG 1989

MEMORANDUM THRU COMMANDER, NORTH ATLANTIC DIVISION

FOR COMMANDER, NEW YORK DISTRICT

SUBJECT: Permit Elevation, Hartz Mountain Development Corporation

1. By memorandum dated 26 May 1989, the Assistant Secretary of the Army (Civil Works) advised me that he had granted the request of the Environmental Protection Agency (EPA) and the Department of Interior (DOI) to elevate the permit case for Hartz Mountain Development Corporation. In this regard, the case was elevated to HQUSACE for national policy level review of issues concerning the mitigation and practicable alternatives provisions of the 404(b)(1) Guidelines.

2. Based on our review of the administrative record and meetings with your staff, the applicant, EPA and DOI, we have determined certain aspects of interpreting and implementing the guidelines should be clarified. Our conclusions are stated in the enclosed report titled Hartz Mountain 404(q) Elevation, HQUSACE Findings.

3. Please re-evaluate the subject permit in light of the guidance provided in our findings and take action accordingly. In order for us to comply with paragraph 8 of the Department of the Army/EPA Memorandum of Agreement, please notify HQUSACE Regulatory Branch as soon as you reach a permit decision. Questions or comments concerning this elevated case may be directed to Mr. Michael Davis of my regulatory staff at (202) 272-0201.

FOR THE COMMANDER:

Enclosure

Patrick J. Kelly
PATRICK J. KELLY
Brigadier General (P), USA
Director of Civil Works

WASHINGTON

Mike Davis
504 4197

17 AUG 1989

MEMORANDUM FOR THE DIRECTOR OF CIVIL WORKS

SUBJECT: Hartz Mountain Permit Elevation Case

This is in reply to your memorandum of July 26, 1989, concerning the subject elevated permit case. We have reviewed your draft findings and concur with your conclusions. You should notify the New York District to proceed in light of the guidance provided in your findings.

The findings provide an excellent analysis of the issues in a complex case. We particularly like the format used to present your analysis and recommend it be used as a model in the future. Mr. Michael Davis, the case action officer, is to be commended for his efforts.

Since much of the guidance and information contained in the findings is applicable to all Section 404 permit applications, please distribute to Corps FOAs.

Robert W. Page
Assistant Secretary of the Army
(Civil Works)

DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:
CECW-OR

17 AUG 1989

Ms. Rebecca Hanmer
Acting Assistant Administrator
for Water
Environmental Protection Agency
Washington, DC 20460

Dear Ms. Hanmer:

Pursuant to the Section 404(q) Memorandum of Agreement (MOA) between the Department of the Army and the Environmental Protection Agency, we are enclosing a copy of our "Findings" which addresses the policy issues you raised in reference to the Hartz Mountain permit case.

We have directed the Army Corps of Engineers, New York District to undertake additional review of the Hartz Mountain permit application in light of the conclusions presented in our findings. Specifically, additional information on practicable alternatives and the baseline values of the existing wetland and proposed wetland enhancement is required before a permit decision can be made. In accordance with paragraph 8 of the MOA we will notify you of the District's decision.

Your interest in this matter and the cooperation of your staff is appreciated. Questions or comments concerning this elevated case may be directed to Mr. Michael Davis of my regulatory staff at (202) 272-0201.

Sincerely,

Patrick J. Kelly
Patrick J. Kelly
Brigadier General (P), U. S. Army
Director of Civil Works

Enclosure

# *HARTZ MOUNTAIN 404(q) ELEVATION*

# HQUSACE FINDINGS

PREPARED BY CECW-OR
25 JULY 1989

# HQUSACE REVIEW FINDINGS
# HARTZ MOUNTAIN PERMIT ELEVATION

The purpose of this document is to present the findings of the Headquarters Corps of Engineers (HQUSACE) review of policy issues associated with a permit application before the New York District (District). This review was undertaken in accordance with the 1985 Memoranda of Agreement (MOAs) between the Department of the Army and the Environmental Protection Agency (EPA) and the Department of Interior (DOI).

## I. BACKGROUND

On 4 August 1986 the Hartz Mountain Development Corporation requested Department of the Army authorization to discharge fill material into 97.41 acres of tidal wetlands within the New Jersey Hackensack Meadowlands District for the purpose of constructing a 3,301 unit residential housing development. Specifically, the project involves the discharge of approximately 950,000 cubic yards of fill material into wetlands dominated by common reed (*Phragmites communis*). A public notice describing the proposal was issued on 22 May 1987, and a public hearing was conducted in June of 1987. A number of comments both for and against the project were received in response to the public notice and hearing. Three Federal agencies, EPA, Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) all objected to the issuance of a permit for the proposed project.

Interagency coordination on the permit application proceeded for approximately 18 months during which time additional information was submitted by Hartz Mountain and their consultants. In July 1988 the District completed the preliminary permit decision process and determined that the project was not contrary to the public interest provided that Hartz Mountain comply with certain restrictions and conditions aimed at minimizing the environmental impacts of the project. Since the Federal resource agencies continued to object to permit issuance, a meeting was held with each agency in accordance with the procedures of the MOAs. As a result of these meetings, each agency provided detailed written comments on their specific concerns. In general each agency's concerns centered on the application of the 404(b)(1) Guidelines practicable alternative requirements, the District's contention that the wetland was of very low value, and the adequacy of the mitigation plan to offset environmental impacts. The District forwarded these comments to Hartz Mountain for response and/or rebuttal. After considering the information contained within the

administrative record, the District completed decision-making in January 1989. Again, the District determined that the permit should be issued. In response to the District's decision, EPA, FWS and NMFS requested meetings with the North Atlantic Division Engineer (NAD) to discuss the permit decision in accordance with Paragraph 6 of the MOAs. As a result of these meetings, NAD forwarded comments and suggestions to the District on 8 March 1989. The comments and suggestions concerned the language of four special conditions which NAD recommended be reworded to increase the viability of the mitigation requirements. The District incorporated these recommendations into the permit conditions and a decision to issue the permit was made on 28 March 1989. On 28 March 1989, EPA, FWS and NMFS were given written notice of the District's "Intent to Issue" the permit.

In accordance with the MOAs, in letters of April 24 and 25, the DOI and EPA, respectively, requested that the Assistant Secretary of the Army (Civil Works) [ASA(CW)] elevate the Hartz Mountain permit decision for higher level review. NMFS, while continuing to object to the project, did not request elevation. On 26 May 1989, ASA(CW), based on recommendations from HQUSACE, granted the DOI and EPA elevation request. ASA(CW) granted the request and forwarded the action to HQUSACE for national policy level review of 404(b)(1) Guidelines issues concerning mitigation and the analysis of practicable alternatives. The elevation request was not based on insufficient interagency coordination.

The information in the following sections presents the results of the HQUSACE review of the complete administrative record of the Hartz Mountain permit application. Clarification of information contained in the record was obtained through meetings with the applicant and associated consultants, the District and NAD staff, the FWS and EPA.

In terms of environmental protection, the 404(b)(1) Guidelines (Guidelines) form an essential component of the Corps' 404 regulatory program. The Guidelines (40 CFR 230) are the substantive environmental criteria to be used in evaluating the impacts of discharges of dredged or fill material. In accordance with the Corps regulations (33 CFR 320 - 330), a 404 permit cannot be issued unless it complies with the Guidelines. HQUSACE's review of this case focused on the policy issues concerning compliance with the Guidelines.

## II. <u>PRACTICABLE ALTERNATIVES</u>

A key provision of the Guidelines is the practicable alternative test which provides that "no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse

impact on the aquatic ecosystem" [40 CFR 230.10(a)]. In this respect, if a 404 discharge may reasonably be avoided, "it should be avoided."

In addition to the basic alternatives test, 230.10(a)(3) establishes a rebuttable presumption against discharges into "special aquatic sites" for non-water dependent activities. A non-water dependent activity does not require access or proximity to or siting within a special aquatic site to fulfill its "basic purpose." Practicable alternatives to non-water dependent activities are presumed to be available and to result in less environmental loss unless clearly demonstrated otherwise by the applicant. The Hartz Mountain project (housing) is clearly a non-water dependent activity. This fact is well documented in the District's decision documents and has not been contested by the applicant. Therefore, the burden of proving that no practicable alternative exists is the sole responsibility of Hartz Mountain, not the District or resource agencies.

A prerequisite to evaluating practicable alternatives is the establishment of the "basic purpose" of the proposed activity. It is the responsibility of the Corps districts to control this, as well as all other aspects of the Guidelines analysis. While the Corps should consider the applicant's views and information regarding the project purpose and existence of practicable alternatives, this must be undertaken without undue deference to the applicant's wishes. These general issues were discussed and guidance provided in the HQUSACE findings for the "Permit Elevation, Plantation Landing Resort, Inc." dated 21 April 1989, a copy of which has been provided to all Corps divisions and districts. Much of the legal and policy guidance in that document is generally applicable to this case, and need not be repeated herein.

In this case, Hartz has clearly stated that their project purpose was to construct 3,301 units of residential housing in the IR-2 area. In fact, a July 86 "planners report" submitted with the permit application stated that "a site geographically located outside the Meadowlands District would not fulfill the 'basic project purpose' of 401(b)(1) [sic] of the Permit program." The IR-2 site is an area designated by the Hackensack Meadowlands Development Commission's (HMDC) master plan as "Island Residential" housing. Hartz acquired ownership to 194 acres of the 238 acre site in 1979. Based on concerns of the District, Hartz ultimately modified the project purpose to expand the potential project area to New Jersey Housing Region 1 (Hudson, Passaic and Bergen Counties). However, Hartz asserts that its purpose remains the construction of a large scale (3,301 units) housing development. While it appears that the District made a conscious effort to view the project from a more basic purpose perspective, this was not the approach taken by Hartz in evaluating potential alternative sites [404(b)(1) evaluation page 5]. This was verified by Dr. Harvey

Moskowitz, Community Planner and consultant for the applicant, who conducted the analysis of alternative sites. This approach seriously flaws the validity of the alternatives analysis and is inconsistent with the Guidelines. Limiting project sites to those that can facilitate a 3,301 unit development may preclude the evaluation of otherwise practicable alternatives. Acceptance of this very restrictive alternatives analysis negates all attempts to otherwise more generically define basic project purpose. In this case, in the "Summary Discussion of the Availability of Practicable Alternatives" [404(b)(1) evaluation page 13] the District states that "There are no practicable alternative sites that are reasonably available to the applicant for the proposed construction activities within the Northeastern New Jersey Region which would <u>meet the applicant's project purpose</u> and the stated need for the project" (emphasis added).

The Guidelines alternatives analysis must use the "basic project purpose", which cannot be defined narrowly by the applicant to preclude the existence of practicable alternatives. On the other hand, the Corps has some discretion in defining the "basic project purpose" for each Section 404 permit application in a manner which seems reasonable and equitable for that particular case. It is recognized that this particular case may be unusual, because it involves unique issues of zoning and land use planning by the HMDC and the apparent scarcity of undeveloped land in the Region 1 area. However, federal concerns over the environment, health and/or safety will often result in decisions that are inconsistent with local land use approvals. In this respect, the Corps should not give undue deference to HMDC or any other zoning body.

At the request of the District, Hartz conducted a search for potential alternative sites in Region 1. Ultimately, 43 sites were identified and evaluated by Hartz's consultant, Dr. Moskowitz. Each site was evaluated based on a set of criteria developed by Hartz. The District reviewed the criteria and concluded that they were "appropriate for reviewing sites for practicability with regard to the Section 404(b)(1) Guidelines." While this approach may be an acceptable method for evaluating alternative sites, we are concerned that some of the criteria were biased to the extent that only sites that meet the applicant's purpose were considered. For example, alternative sites less than 50 acres were not considered practicable because they would not facilitate a 3,301 unit development and therefore "achieve the applicant's stated project goals" [404(b)(1) evaluation page 8]. On this subject the District states:

> "Based on the applicants goal's for a profit, it must be presumed that the size of a potential alternative site is of primary importance. A smaller parcel of land could be considered a practicable alternative for a residential housing project although it could not accommodate a

project nearly the size that is the subject of the present permit application." [404(b)(1) evaluation page 7]

In this case the District's administrative record gives the appearance of having given too much deference to the applicant's narrowly defined project purpose. This may have very well resulted in the exclusion of otherwise practicable alternatives.

The District goes to great length to explain the criteria utilized by the applicant and the justification for each [404(b)(1) evaluation page 8]. However, no information is provided in the decision documents on the specific sites, the ratings they received, or why they failed as practicable alternatives. At a minimum, a table of the sites listing this information should have been included in the 404(b)(1) evaluation. In regard to the actual evaluation of the 43 potential sites, we observed at least a few discrepancies in the data submitted by the applicant. For example, two adjacent sites (4 and 5) were given different ratings on accessibility to public transportation. Of more significance is the fact that the IR-2 site was not evaluated against the criteria used for the other sites. Our estimates indicate that the site may in fact not pass as a practicable alternative based on the applicant's own system for analyzing alternatives. Failing to evaluate the project site when using this type of evaluation system is inappropriate and indicates that the applicant has not rebutted the presumption against the discharge of fill material into special aquatic sites.

Throughout the decision documents the District mentions the need for housing in the Region and references New Jersey Council on Affordable Housing (COAH) information [Statement of Findings (SOF) page 14, 404(b)(1) evaluation page 11, Environmental Assessment (EA) page 2]. While the need for all types of housing in the Region may be very real, we are concerned that the administrative record does not clearly demonstrate the existence of such a need. The COAH information focuses on the need for low to moderate income housing and this portion of the housing need is not questioned. However, it appears that the District relied on the COAH data to substantiate the need for housing above the moderate income level. Admittedly the COAH information translates an actual need of 42,534 low/moderate units to an overall figure of 213,000 housing units. This is based on the number of market rate units that may be required to support the actual low/moderate housing needs. Use of this information to justify an overall housing need may not be appropriate. Further, reference to a COAH letter on page 11 of the 404(b)(1) evaluation is misleading if not inaccurate. The District states:

"The 27 September 1988 correspondence from the State of New Jersey's Council on Affordable Housing (COAH) substantiates the applicant's showing that no reasonably available

> practicable alternative sites to the proposed development exist by focusing on the 'compelling need' for locating the housing in Secaucus at the Mill Creek site, at the densities mandated by the Hackensack Meadowlands Development Commission zoning regulations."

What the referenced COAH letter really states is that there is a need for 42,534 low to moderate income units and that it may take four market units per low/moderate unit to support such housing. In regard to the "compelling need" at the Mill Creek site (IR-2), the COAH letter states:

> "The COAH supports the development of <u>affordable housing units</u> at the Mill Creek site as a meaningful step toward addressing the compelling need for <u>such housing</u> in Secaucus and Region 1." (emphasis added)

The proposed project will provide a maximum of 330 (10% of total) low to moderate income units at the IR-2 site. The administrative record and discussions with the applicant indicate that it is likely that only one half of the 330 units will actually be built at the IR-2 site. The decision documents consistently state that 10% to 20% of the project will be dedicated to low to moderate housing. This is clearly not the case and the record should reflect such. <u>Further, the need for housing of any type and the zoning requirements of HMDC cannot override the Guideline's requirement to select the least damaging practicable alternative.</u>

**CONCLUSIONS:**

1. For purposes of this case only, the basic project purpose should be defined as "construction of a large scale, high density housing project in the Region 1 area." That does not necessarily mean a project of 3,301 units in one contiguous location as proposed by Hartz. <u>The District should determine the minimum feasible size, circumstances, etc., which characterize a viable large scale, high density housing project</u>. The District may require the applicant to provide information that facilitates completion of this determination. Clearly Hartz has previously determined that a development of 2,748 units would be feasible. It may very well be that a smaller development (i.e., < 2,748 units) would also be viable. The permit decision documents should be corrected to reflect the project purpose noted above (i.e., references to satisfying the applicant's project purpose should be deleted).

2. Once the minimum feasible size, etc. has been determined in accordance with (1.) above, a revised alternative analysis should be completed by Hartz. The District must carefully evaluate the criteria used to compare alternative sites. The alternatives analysis must be objective and balanced, and not be used to provide a rationalization for the applicant's preferred result (i.e., that

no practicable alternative exists). The IR-2 site must be included in the alternatives evaluation and added to the administrative record.

3. The alternative site data should be made part of the decision documents. This should include a listing of all sites, their evaluation scores and a summary of the final determination of practicability.

4. Information on the need for housing must be accurately cited in the decision documents and additional information on the overall housing need (i.e., above moderate level) should be provided.

## III. MITIGATION[1]

As previously discussed, the Guidelines establish the substantive environmental criteria to be applied in the evaluation of potential impacts associated with discharges of dredged or fill material into waters of the United States. In addition to the "practicable alternative" test in 230.10(a), the Guidelines state that a discharge cannot be approved, except as provided under 404(b)(2), if it results in significant degradation of waters of the United States and, unless all appropriate and practicable steps have been taken to minimize potential adverse impacts on the aquatic ecosystem [230.10 (c) and (d)]. These form an important part of the current approach of requiring mitigation in the 404 regulatory program. Mitigation is also a required consideration under the Corps' Public Interest Review [33 CFR 320.4(r)].

As a general rule, once the least damaging practicable alternative has been selected, appropriate and practicable steps must be taken to mitigate the project impacts. Determining the amount and type of mitigation is often difficult at best. In particular, compensatory mitigation for wetlands loss engenders a considerable amount of controversy and discussion among regulatory and resource agencies and the development community. In order to improve consistency, Army and EPA are currently working on a 404 mitigation policy.

Pending the promulgation of the joint mitigation policy, the Corps should require mitigation measures which will provide compensation, to the maximum extent practicable, for all values and functions that are lost or adversely impacted as a result of

[1]The discussion of mitigation that follows, and any subsequent requirements, have no bearing on the previous discussion and requirements concerning the availability of practicable alternatives.

a proposed development in waters of the United States. As with other permit specific Guidelines and public interest decisions, a determination of mitigation requirements will be made by the Corps. Such decisions should be made after appropriate consultation with Federal and state resource agencies. The Corps decision must be made in a manner that recognizes the ecological functions of special aquatic sites, in this case wetlands.

A prerequisite to developing a wetlands compensatory mitigation plan is the establishment of values and functions of the existing wetland system. Without the benefit of baseline information, the permit decision-maker cannot determine an appropriate mitigation level to find compliance with the Guidelines. As a matter of policy, the Corps should not make permit decisions before obtaining the necessary and appropriate information on the value of the specific resource that would be lost to a proposed discharge of dredged or fill material if the permit is granted. This information may be obtained from the applicant, in-house studies, technical assistance from experts at the Corps Waterways Experiment Station (WES) or universities and previously published reports to mention only a few sources. It is incumbent upon the Corps to review the data carefully to ensure that the information is scientifically sound and can be supported if challenged.

In the Hartz Mountain case an extensive mitigation "concept" was proposed by the applicant. The District relied heavily on the potential success of this concept in reaching a decision to issue the permit. The basic premise of the Hartz mitigation concept was that the existing wetland system was highly degraded and of very low value. In this regard, Hartz maintained that they could enhance low value wetlands (both on-site and at two off-site locations) to a point where they could compensate for the direct loss of 97.41 acres. This assumption is based on a presumed "successful" mitigation project currently under way by Hartz on another part of the IR-2 site. This 63 acre mitigation project was required as part of a 1983 Department of the Army Permit to fill 127 acres of wetlands for commercial and industrial development. To date, no comprehensive evaluations have been completed to substantiate the claims of success on this mitigation project in terms of overall wetland values. For the current project, Hartz determined, using the FWS Habitat Evaluation Procedure (HEP), that they would have to enhance 93.74 acres of wetland and create 22.12 acres of open water canals to compensate for the loss of 97.41 acres. In addition, Hartz proposed 8.84 acres of "raised islands" for upland habitat and 9.40 acres of wetlands preservation.

Throughout the District's review of this case there as been significant disagreement between Hartz and the resource agencies on the actual value of the ***Phragmites*** dominated wetlands within the project area. The applicant's HEP, which was modified several times, concluded that the area has "relatively low existing fish

<u>and wildlife and ecological value</u>" (emphasis added) (EA page 6). An Advanced Identification field team from the District, EPA, FWS, NMFS, New Jersey Department of Environmental Protection and HMDC conducted a analysis of the Hackensack area using the Corps Wetland Evaluation Technique (WET). According to the District, the "draft WET documents have shown that the general regions encompassing the proposed development site and mitigation areas have <u>high value potential for fish and wildlife, as well as the potential for having moderate to high general ecological value</u> ..." (emphasis added) (EA page 6). The District has indicated that the WET analysis was not specific to the project area and was more of a "windshield" survey. EPA and FWS requests for permit elevation were based, in part, on the lack of definitive data on the values of the project and mitigation sites. FWS continues to question the validity of the applicant's application of the HEP (a FWS methodology) process.

Based on the decision documents for this application, it appears that the District generally concurred with Hartz on the low wetland value of the project area. Their position was based on the HEP evaluation and other environmental data collected by the applicant. However, the addition of Special Conditions (A.) and (D.) seem to indicate that their support was somewhat tacit and that questions on the wetland values remained. Condition (A.) requires Hartz to perform a site specific WET using environmental data from other agencies and the HEP generated information. This information is to be used to "confirm that the proposed wetland mitigation values compensate for the <u>aggregate</u> value of the wetland functions lost to the filling activities..." Special Condition (D.) requires Hartz to undertake a comprehensive sampling and data collection program which includes the establishment of baseline information for the project area. While Hartz has provided biological, chemical and physical data in the form of various surveys and studies conducted over the years, an updated comprehensive scientific report on the existing conditions does not exist in the administrative record. <u>From a policy perspective, we believe that a valid Guidelines determination cannot be made without the benefit of an appropriate assessment of the pre-project values of the impacted resource</u>. This information is equally important in making the Corps public interest determination. <u>Further, this assessment should be completed before a final permit decision is reached</u>. The level and sophistication of information required will vary from application to application depending on the size and nature of the project. It is recognized that in a small number of cases (e.g., unauthorized fill), baseline information may not be readily obtainable and best professional judgement must prevail. However, the piecemeal approach of assessing current wetland values and the reliance on such information as an "April 1986 comprehensive, natural resources survey of the subject parcels and the Hackensack River" are causes for concern.

According to Hartz, completing the proposed mitigation would result in a 20% net increase in overall estuarine value in the project area. For purposes of the mitigation discussion the project area is defined as the 231.51 acre universe of the IR-2 site and the two off-site mitigation areas. The existing estuarine value of the project area was estimated at 38% of its potential. A 20% increase would result in a project area that functions at 46% of its potential estuarine value. When the 97.41 acres of project fill, 8.84 acres of "islands" and the 9.40 acres of preservation are removed from the project area[2], 115.86 acres remain for marsh enhancement and open water. In order to obtain their estimated 20% overall increase Hartz will have to enhance the 115.86 acres to 91% of their potential estuarine value. In this respect, we are concerned about Hartz's, or anyones, ability to increase values to such a level. If the open water is subtracted, the remaining 93.74 acres of wetland would have to be enhanced to 113% of its potential estuarine value. Clearly, this would not be possible. In either case additional acreage may be required to achieve the 20% net increase in values required.

Another issue that is of concern is the inclusion of "fringe" wetlands and open water in the mitigation plan. Over 33 acres of the mitigation credit consist of a series of canals and adjacent narrow strips (fringe) of intertidal plantings among 3,301 housing units. The overall wetland value of this part of the mitigation should be documented. The HEP evaluation looked at this area as one 33.85 acre tract and not as one that was dissected by a large residential development. The applicant's main purpose for this part of the plan may very well be aesthetics.

An issue that was initially discussed in the HQUSACE permit elevation recommendations to ASA(CW), was the proposed issuance of the Hartz permit prior to receipt of a detailed mitigation plan. In this case, permit conditioning appears sufficient to ensure that a detailed plan will be submitted for District approval prior to the discharge of fill material. However, at a minimum, the permit plans should have provided enough information to accurately reflect the work proposed (e.g., typical cross sections, etc.).

**CONCLUSIONS:**

1. Hartz should be required to complete a comprehensive baseline study of the IR-2 site, off-site mitigation areas, and the previous 63 acre mitigation site before a final permit decision is made. The District, in consultation with FWS, EPA and NMFS will determine the scope of the study and the methods used. The final call on the study will be the District's.

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[2]Correctly, these areas were not counted by the applicant or the District in determining the amount of marsh enhancement required.

2. The District, not Hartz, should complete a site specific WET evaluation before making a permit decision. We strongly encourage the District to utilize experts from WES to undertake this task. Funding for work of this nature has previously been provided to WES by HQUSACE and initial discussions have confirmed the availability of the appropriate WES staff.

3. The wetland replacement value of the fringe wetlands and open water at the IR-2 site should be reevaluated. Documentation of its value should be included in the record.

4. Once information is obtained from the studies noted in paragraphs one through three above, a determination of the value of the existing *Phragmites* marsh and, as appropriate, the amount of compensatory mitigation required to compensate for the lost resource should be completed. Based on those determinations, a final permit decision should be made.

5. After completion of the above, if a decision is made to issue the permit, Hartz should be required to submit more detailed permit plans. While we do not expect final drawings, basic information such as access between islands at the IR-2 site and typical pre and post project cross sections at all mitigation sites should be included.

## IV. GENERAL CONCLUSIONS

A review of the voluminous administrative record reveals the extensive amount of effort on the part of the District to evaluate this application. Severely understaffed and working in a difficult geographic area, they should be commended for their overall accomplishments in the regulatory program.

From the guidance presented in this document, the general conclusion should be drawn that the Army Corps of Engineers is serious about protecting waters of the United States, including wetlands, from unnecessary and avoidable loss. The Corps districts should interpret and implement the Guidelines in a manner that recognizes this. Further, the Corps should inform developers that special aquatic sites are not preferred sites for development and that non-water dependent activities will generally be discouraged in accordance with the Guidelines. When unavoidable impacts do occur, the Corps will ensure that all appropriate and practicable action is required to mitigate such impacts. The mitigation must be properly planned with stringent permit conditions to ensure that it accomplishes stated objectives. Compliance monitoring by Corps districts must be an integral part of this process.